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Chemical Engineering

JANUARY 1957

POPULATION

challenges chemical technology

JANUARY 1957

JOHN R. CALLAHAM, Editor

Three New Series . . . .

You will find, beginning in our first two issues of 1957, three brand new editorial series:

- Flow Through Packings and Beds
- How to Estimate Engineering Properties
- CE's Flow Formula File.

First new series—flow through packings and beds—begins in this issue. It will run for 12-15 months.

Max Leva, internationally known authority, makes available for the first time the most important information on flow of fluids through packed towers and reactors. Leva's series, practical in approach, will be of most interest to men in design or development work.

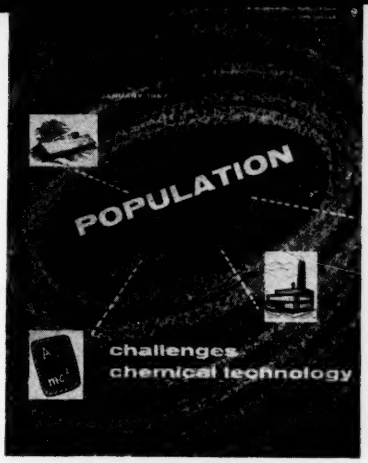
Second new series—how to estimate engineering properties—starts next month; it will run for at least a year.

Wallace Gambill of Union Carbide Nuclear evaluates methods the chemical engineer can use to estimate such properties as thermal conductivity, heat capacity, and the like. This material has been collected from scattered sources, is now being published in one place for the first time. It will be of most help to those in research and development, but is the type of working data every engineer will want to save.

Third new series—CE's flow formula file—begins this month (see Plant Notebook). It will continue for 12 issues or more.

This series will include over 50 of the most useful flow formulas used by chemical engineers. They have been collected and tested, over a period of a dozen years, by Maxey Brooke, an engineer in Texas. This is clip-and-save material of practical value to all engineers.

When completed, each series will be equivalent to a small book—a book of practical and permanent value to engineers in all job functions.



GUIDED TOUR

To chemical engineers everywhere: here's a challenge; an opportunity

Symbolized on the CE cover this month are three challenges hurled at chemical technology by a boom in population. Annual CE review and forecast explores our progress in (1) supplying basic needs, (2) keeping the wheels turning, (3) stretching manpower resources. (p. 211)

Escape from tradition

Modern attacks on the old, old problem of designing packed towers have razed a lot of empirical data. Here—especially for design engineers—is the introduction to newest practical developments. (p. 204)

How much for mineral-free water?

Now—the first thorough study of the most economical way to get mineral-free

UIDED TOUR

water from surface supplies. Cost comparisons for all commercial ion exchange methods will guide your selection. (p. 206)

Guide to profitable trapping

In answer to a long-standing need for reliable information, this four-way article will banish steam-trap troubles by telling how to choose, size, install and maintain for top performance. (p. 227)

To make your own flow file

A brand new series to make your job easier starts this month. These flow formulas —listed with applications and other data— can be clipped and filed to build a compact reference. (p. 264)

If you want to change jobs

You probably won't have much trouble finding a new job if you really want to change this year. But for the real plums, competition is fierce. Our survey appraises your chances in various categories. (p. 281)

To keep pace with development, design, production and technical management in the chemical process industries, more engineers subscribe to CE than to any other magazine in the field. Paid circulation of this issue:

42,075

Chemical

JANUARY 1957, Vol. 64, No. 1

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Engineering

CE Refresher

Plant Notebook

Corrosion Forum

People in Chemical Engineering

You & Your Job

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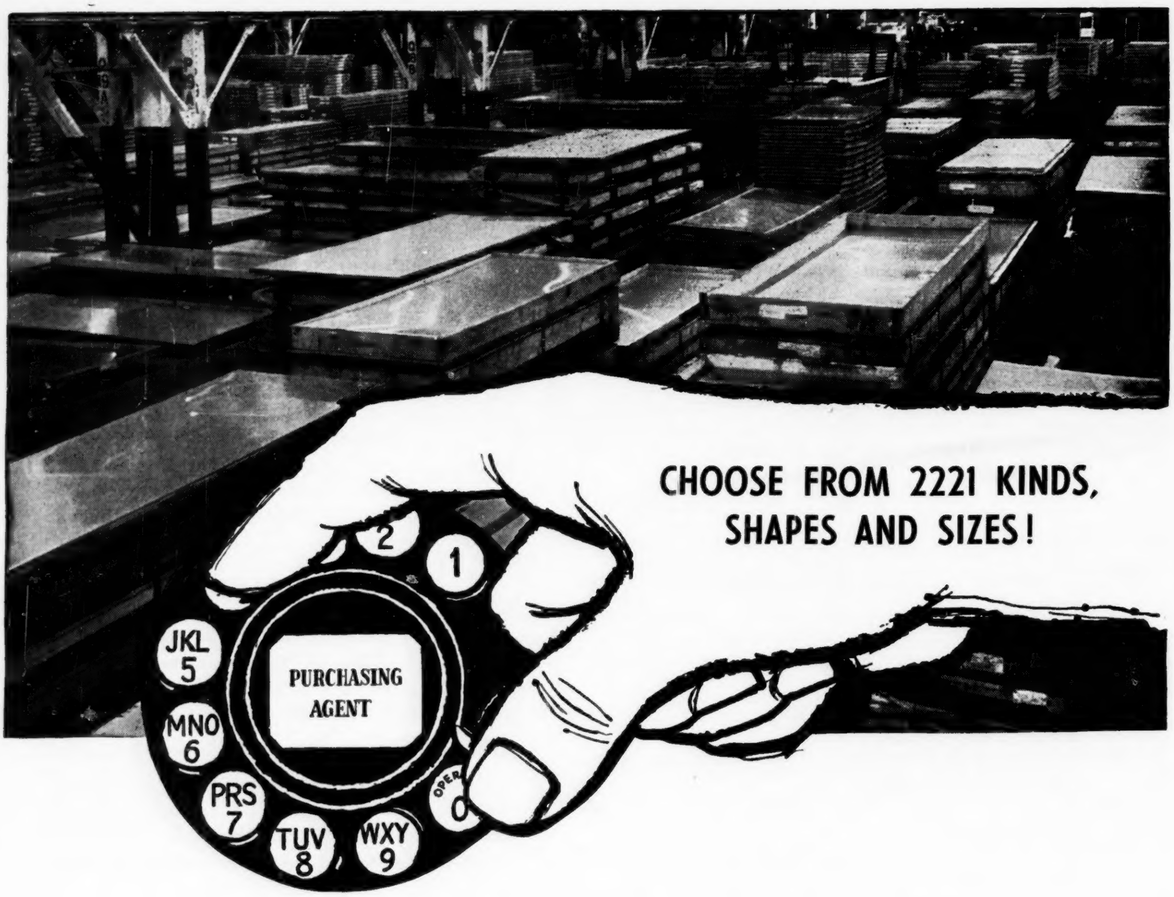
CHOOSE FROM 2221 KINDS, SHAPES AND SIZES!
PURCHASING AGENT

Chemical Engineering

Developments

JANUARY 1957

Department Index

Sketch shows Cosden Petroleum's new ultra-fractionation and styrene manufacturing plant as it will appear when completed in early 1957. The four columns — each almost 200 feet high —will be among the tallest ever erected!

The plant that "couldn't be built" now under construction

At Cosden's Big Spring, Texas, refinery, Badger is erecting the first plant ever designed for the recovery of ethyl benzene by distillation. The process *first* became commercially practical when Badger Engineers developed Ultra-fractionation.

Now, instead of marketing catalytic reformer effluents as mixed solvents, this new distillation process will make it possible for the client to produce a pure product with a far higher profit margin.

This achievement in *Creative Engineering**, like all intangibles, can never be shown on the blueprints. Yet it is the "Precious Plus" in Badger's performance that is making Cosden's plant possible!

Other leading companies, too, find Badger's *plus* in performance of precious advantage — whether their need is design, engineering or construction. How else explain the unusual growth Badger is enjoying?

+ **You need new "yardsticks" to measure the plus performance of Badger.** For the abilities of this dynamic organization go far beyond what can be shown on blueprints—and it's such intangibles that add up to better processes and plants, faster and at lower cost.

*Creative engineering . . . whether your process problem is common or complex, Badger engineers solve it with fresh thinking that frequently produces new efficiencies, unexpected savings.

Broad experience . . . Badger Engineers are more than competent—most staff members are recognized authorities in their fields.

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DEVELOPMENTS . . .

JANUARY 1957

Chementator

H. T. SHARP

√ **Ethyl Corp. has a process for tetraethyl lead that it says is radically different and has Proved superior to known processes. Process involves reaction between a metal alkyl and a lead compound.**

√ **Dupont is reported planning a $1\frac{1}{2}$-million plant to synthesize L-lysine from furfural.**

√ **Mead Corp.'s process for recovering chemicals from the waste of neutral sulfite and acid bisulfite pulping is about to get commercial tryouts at two pulp mills.**

√ **Stone & Webster and Thermal Research have a new high-velocity combustion system for making sulfur dioxide from liquid sulfur. Small size, low installation and maintenance costs are reported gains.**

√ **Stanford University researchers have learned how to make molten metals "wet" other solid metals. Their method, which involves heating the solid metal to a certain critical temperature in a vacuum, should greatly increase efficiency of some types of atomic power reactors.**

Shell switches to acetonitrile solvent

Shell Chemical now uses acetonitrile instead of acetone as the extractive distillation solvent for separation of butanes and butylenes at its Torrance, Calif., butadiene plant. The new technique appears to have wide application—even wider than acetone extractive distillation, which Shell pioneered in the early '40's and now licenses.

Despite acetonitrile's higher price (about 45¢/lb., compared to acetone's 8¢/lb.), the improved separation that's achieved makes acetonitrile an economical choice. At Torrance, for example, Shell was able to increase capacity by 58% with only minor changes in equipment. With acetone, this capacity boost would have required a multimillion-dollar major expansion.

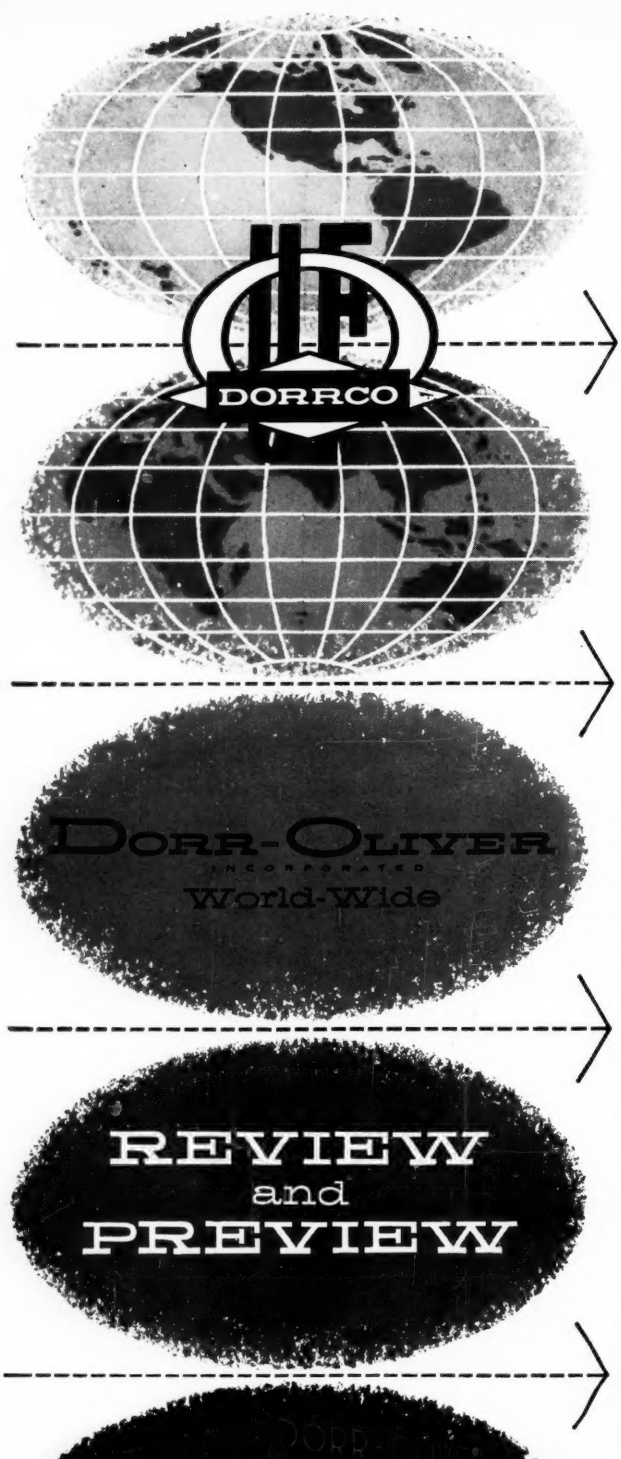
In addition to separating olefins and paraffins, Shell feels the technique can be applied to separation of various unsaturated systems and possibly even to aromatic-aliphatic systems. Besides replacing acetone, acetonitrile might find application where other solvents are now used for extractive distillation. Shell Development Corp. handles licensing.

Rubidium and cesium cost cuts loom

A new company, new plant, new product and new process may make rubidium and cesium chemicals commercially available at relatively low costs. This would open the door to new uses for these now-scarce materials.

San Antonio Chemicals, newly formed American Potash & Chemical subsidiary, will put its $750,000 plant on stream by the end of March to recover mixed alkali carbonates from the alkali-rich end liquors of American Lithium Chemicals' (another Ampot subsidiary) lithium hydroxide plant (*Chementator*, Jan. 1956, p. 110). Process to be used involves filtration, granulation and dehydration of salts in these liquors.

Now being built near ALC's plant at San



1956 has, in many respects, been a record year for us . . . characterized by advances in technology and an all-time high in volume of new orders and also billings throughout the world. This meant a year of strenuous adjustment due to the necessity of increasing our productive capacity to parallel our growing volume of business.

The acquisition of the Merco Centrifugal Co. of San Francisco on February 1, added centrifugals to our product line. This natural outgrowth of our cyclone work has proven to be a most successful move. Similarly, the year has demonstrated the strength of our new Canadian subsidiary, Dorr-Oliver-Long of Orillia, which became the newest member of our corporate family on January 1, 1956. Yet another step in the overall corporate growth picture was the completion of plans to add the ninth member of our overseas family, Dorr-Oliver Pty. Ltd. of Australia on January 1 of 1957.

Steps in matching our productive capacity to our growing needs included a million dollar expansion of our Hazleton plant scheduled for completion at the year's end and the opening of a sizable new production facility nearby in Pennsylvania. Currently, a long term expansion and reallocation program is underway which will step-up our ability to produce, and to serve, still further.

Growth and change in other operating areas of the parent company also kept pace. A broad reorganization of our domestic sales structure added new geographical divisions and was principally designed for better sales coverage and service. In engineering, the pressure of increased volume resulted in the opening of a branch engineering office in Pennsylvania, close by our East Coast plants, which has proven to be most worthwhile.

FLUOSOLIDS SYSTEMS — A large steel producer in the United States finalized plans for a new fine coal washing plant using a two Reactor FluoSolids Coal Drying System designed to handle 600 tons of metallurgical coal per hour. In the non-metallics field, three fluidized Reactors went into operation — two in the Detroit area drying blast furnace slag used in cement manufacture, and the other calcining clay in Scotland. Systems are now under construction to dry and preheat oyster shells and to calcine Massachusetts limestone.

Four new installations in Japan will roast 265 tons of zinc concentrates daily, producing both a readily usable calcine and SO_2 bearing gases for contact sulfuric acid manufacture. During the year two installations in the U. S. and South Africa operated successfully roasting copper for direct electrowinning. And pyrite roasters were ordered for a Canadian uranium mill, Chilean and Nicaraguan copper concentrators, French and Philippine fertilizer plants, and two Scandinavian pulp mills. In all, 21 fluidized Reactors were sold in 1956.

PULP AND PAPER — Brown Stock and Bleach Washers, Savealls, Vacuum Deckers and a Recausticizing System for a new Arkansas Kraft mill represented one of the largest equipment orders in D-O history. Another Brown Stock Washing System in India will go into operation next year as will similar type systems in Peru, France and the Pacific Northwest, and a pulp washing installation in Michigan.

Our subsidiaries abroad have marketed Recausticizing Systems in Brazil, India, Sweden and Finland and a number of new or expanding plants in this country will also use the familiar D-O chemical reclaiming system. Evidence of continued popularity of the American Saveall is a repeat order for six units of various sizes placed by a Massachusetts paper producer.

FERTILIZER — One of the highlights of the past year was the largest single D-O order ever received involving a phosphoric acid and 200,000 ton per year triple superphosphate plant for a Florida producer. The scope of our services on this project includes architect-engineer design, supply of equipment and construction materials, and supervision of erection and initial operation of the plant.

Other major design projects undertaken during the year were a 350,000 ton per year complete granular fertilizer plant in Great Britain, a 350 ton per day ammonium phosphate installation in Montana, and a phosphoric acid plant for Venezuela designed to produce 50 tons of P_2O_5 per day. During the year construction of a D-O engineered Scottish granular fertilizer plant was virtually completed, and Traveling Pan Filters were ordered for the difficult gypsum-phosphoric acid separation in a number of new chemical fertilizer plants around the world.

ALUMINA AND MAGNESIA — Plant expansions in both fields contributed heavily to the year's business as four of the world's major alumina producers in the Gulf Coast area and Jamaica ordered a total of 45 Filters, 20 Thickeners and 26 low pressure pumps of various types and sizes. In Michigan, three magnesia-from-brine plants will add a variety of agitation, filtration and thickening equipment; while a West Coast magnesia-from-sea water producer will employ extensive D-O equipment.

POLYETHYLENE — Our contribution to one of today's most spectacular and rapidly growing fields — polyethylene—is the Merco Pressure Centrifuge, developed specifically for high pressure, high temperature operation. The basic unit was developed, designed and manufactured in record time to keep pace with the expanding industry. First commercial Centrifuges will go on stream early in 1957 separating catalyst from liquid polyethylene.

WATER TREATMENT — Our subsidiary in The Netherlands entered their largest water treatment order in history for a complete plant to serve Zonguldak, Turkey. In the U. S., major expansions at Kansas City, Missouri; Dallas, Texas; and Springfield, Ohio; will incorporate D-O equipment in the flowsheet, while PeriFilter Systems will treat water for a Minnesota iron ore producer and for the municipalities of Summit, New Jersey and Fountain City, Tennessee.

METALLURGICAL — Recently placed on the market, the DSM Screen is an ingenious, high capacity screen capable of separations as fine as 200 mesh. Adapted from the Dutch design, the unit has operated very successfully on coal and will handle a wide variety of nonfibrous feed slurries. Other highlights of the year include a number of Thickener-Filter combinations and Bowl Desiltors installed in Eastern coal fields, a D-O equipped iron ore washing plant in California, and a variety of cement plant expansion equipment orders.

SUGAR — Next year going into operation in Cuba and Puerto Rico will be the two largest complete RapiDorr Clarifiers constructed to date. Even larger, however, is a 36 foot unit recently converted to RapiDorr design in the world's largest cane mill where thirteen thousand tons of cane are processed daily in four Dorr Clarifiers and four O-C Filters.

In the beet sugar fields of the western United States a number of First Carbonation Thickeners were converted to a new design substantially increasing capacity of existing units at minimum expense.

STARCH — The addition of Merco equipment to the D-O product line has been of significant importance, particularly in the starch industry. Merco Centrifuges and DorrClone units comprise a new and complete D-O starch washing system, the first of which was ordered this year for an Illinois cornstarch plant. In this installation, which also represents one of the largest DorrClone orders to date, Mercos will handle gluten-starch separation and gluten thickening, while degritting and starch washing will be performed by DorrClone units.

In other parts of the world a similar Merco-DorrClone system has gone into operation in Canada and a large number of DorrClones and DSM Screen units are processing potato starch at a Dutch plant. In India, Merco Centrifuges and Mercone Screening Centrifuges, introduced last year, will wash starch and dewater fibre at a large cornstarch plant. Our Associates in The Netherlands have also received orders for DorrClone starch washing systems in Great Britain, Germany and Holland.

RESEARCH AND DEVELOPMENT — As a matter of policy, fundamental research continues on our expanding line of basic unit operations. The principle of operating in many different but allied fields stimulates situations wherein fundamental research can produce new and useful products and processes. Such is not possible when interest is confined to but a few basic operations, as in our early years.

Similarly, general company development is continuing the search for new products allied in some manner with our experience and facilities. In this search we count heavily on the assistance and cooperation of our Associates throughout the world.

PETROLEUM — The Hi-Rate Pressure Filter has proven successful as a high-capacity water filter in oil field secondary recovery operations with rates higher than those of conventional units. Initial test work in other fields indicates the versatility and possibility of unusually widespread application of this new filter.

A variation of the D-Sander, first introduced in 1955, has been developed for removal of fine silica from rotary drilling fluids. The petroleum industry purchased during the year over one hundred D-Sanders of both basic types.

INDUSTRIAL WASTES — D-O equipped treatment plants handling chemical wastes were installed by a German and two British chemical manufacturers. The former installation incorporates the first D-O equipment to be purchased for this purpose in Germany since World War II. Next year two Southern pulp mills will clarify wastes in giant 300 foot Thickeners installed in earthen basins, and a U. S. steel company will recover flue dust in a completely D-O designed installation. Two similar flue dust recovery stations were also ordered from our British subsidiary during the year.

The year's impressive record of sales and technical accomplishment has been made by the hard work of our staff in every corner of the globe. The success of our operations naturally rests wholly with them, despite the importance of the tangible facilities and tools with which we work. In the year now drawing to a close this was again demonstrated, and as the tools and facilities we give them expand and become of better quality, so will our staff be able to produce greater volume and increasing returns.

November 20, 1956

J. D. Hitch, Jr.
President

Antonio, Tex., the new plant's initial product will be a mixture of water-soluble salts—about 70% potassium, 23% rubidium and 2% cesium carbonates. Product is expected to find initial markets in glass and ceramic production and as an adsorbent in carbon dioxide purification plants.

But certainly the product's most interesting, if not biggest, potential is as a relatively cheap source of rubidium and cesium salts and metals. Their current high price (about 75¢/gram for carbonates) restricts usage of these materials to the pounds-per-year range, with their major application in the electronics industry.

Launching a three-way research program, Ampot aims to uncover potential uses for the individual carbonates and the metals, as well as practical processes for isolating the carbonates and ways to reduce them to the metals. Though Ampot won't discuss this research, ion exchange appears to be one route worth exploring. (The usual method involves costly repeated fractional crystallizations.) Once relatively low-cost pure carbonates are available, there are several possible ways to make the metals.

Allied Chemical gets the nod

Atomic Energy Commission has decided that of the seven responses to its request for industry's help in making refined uranium salts (*Chementator*, Nov. 1956, p. 108; Oct. 1956, p. 108), the proposal of Allied Chemical's General Chemical Div. will cost the government least money. As a result, Allied will start work on a plant to fill a five-year contract calling for up to 5,000 lb. U_3O_8 equivalent per year. Deliveries begin April 1, 1959.

Allied proposes to supply the uranium as the hexafluoride. In this form it can be charged directly into AEC's gaseous diffusion plants for isotope separation. Other proposals are believed to involve making salts, such as the trioxide or the tetrafluoride, which AEC would then have to convert to the hexafluoride. Hence, AEC's total costs are lower with Allied's plan.

Allied's process is a newcomer to large-scale salt purification, though it has been used experimentally in both salt and fission-product processing. Essentially, Allied will fluorinate crude uranium concentrates and distill off the volatile hexafluoride. Reported problems with this method include the relatively high cost of fluorine and removal of fluorine-consuming silicon from the concentrates.

Cost projections aside, AEC's willingness to gamble on a relatively untried process is attributed by observers to a desire to infuse new industrial blood into the nation's atomic energy program. The commission itself hailed its decision as "a significant step in the program to broaden industrial participation."

Detergents from sugar nearer to market

New nonionic detergents made from sugar moved a big step closer to production and marketing with the recent granting of seven process licenses by the Sugar Research Institute, the patent holder. Chas. Pfizer, Berkeley Chemical, an unnamed sugar company and four foreign firms now hold licenses.

In addition, the big three in the detergent world—Procter & Gamble, Colgate-Palmolive and Lever—have been receiving reports of SRI-sponsored research, and at least two of the three are known to be actively studying the process.

Developed in the laboratories of Foster D. Snell, Inc., these detergents are reported to be nontoxic, nonirritating, oderless, tasteless and only slightly soluble in water. (See *Chem. Eng.*, Jan. 1956, p. 142 for information on preparation and properties.) They're also expected to be cheap. Reportedly, a 10-million-lb./yr. plant would permit a selling price of 25¢/lb.—against about 35¢/lb. for alkyl aryl sulfonates from a plant of the same size.

Neither Pfizer nor Berkeley have set dates for full-scale commercial production, but both are running pilot operations. Problems in purification and drying are said to be stumbling blocks.

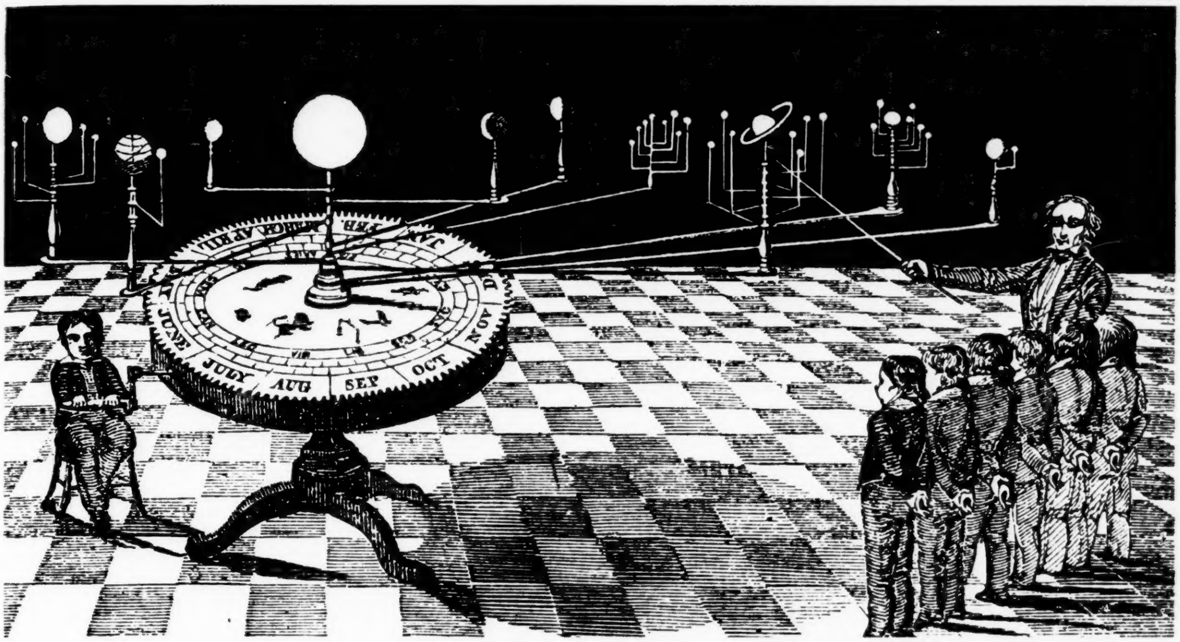
Dollar-a-pound titanium on the way?

High-quality titanium at a cost of less than $1/lb. is anticipated from a fused-salt electrorefining process about to be tried in a 10,000-20,000-amp. semicommercial cell now being installed at the Bureau of Mines' Boulder City, Nev., station.

Using cheaper raw materials than present chemical reduction processes and adaptable to continuous operation, the process also promises to cut costs of refining other metals. In fact, the bureau has just begun work on a $110,000

(Continued on page 112)

The revolution of the planets—Bettman Archives



research project that aims to adapt electrorefining to recovering zirconium from impure sponge metal, mill scrap and zirconium alloys. This work will be done for AEC.

Heart of the new process lies in use of a 5% divalent titanium complex (12.4% $TiCl_2$) in fused sodium chloride as the electrolyte. This mix can be made by passing finely divided molten sodium droplets through $TiCl_4$ at 1,200 F. in a tower reactor. (It is essentially the first stage of the Bureau's two-stage sodium reduction process described in *Chementator,* Mar. 1956, p. 110.)

Almost any mixture of titanium-bearing metals can serve as the cell anode. Cathode is mild iron, with an area one-fourth to one-half that of the anode. The unit operates at 1,560 F. under a helium atmosphere. Product comes out as coarse, granular crystals, readily melted into ingots.

USBM starts "emergency recruitment"

To help speed up research and development on its minerals and metals programs (such as that above), the Bureau of Mines is now actively hunting 142 new professional employees—including some 23 chemical engineers, 28 chemists.

In 1956 the bureau got something better than $1 million extra from Congress for research on strategic materials in the belief that they could get the added personnel to use it. So far they haven't, and about $500,000 is sitting ear-marked for salaries for yet-unhired people.

Jobs open are located throughout the country, with a few overseas. They range from Grades 5 through 13, with most either Grade 9 ($6,115/yr.) or 11 ($7,035/yr.). The bureau emphasizes that these aren't emergency jobs, but career opportunities.

Growing use spurs rare earths expansion

Quietly, without the usual announcements, several producers of rare-earth metals have launched capacity expansions to fill newly signed contracts with AEC. Lindsay Chemical, Michigan Chemical and Heavy Minerals Corp. are involved.

Though contract details haven't been revealed, it has been learned that AEC wants substantial amounts (in dollar terms, at least) of four metals—gadolinium, samarium, europium and yttrium. First three will be used in nuclear reactor control rods. The commission feels that these metals are potentially much superior for this use than materials currently used—hafnium and boron. Yttrium is wanted as a structural material in reactor design. Information on its exact use remains classified.

Options new hafnium separation process

U. S. Industrial Chemicals, a division of National Distillers Products Corp., has an exclusive option on an Australian process for separating hafnium impurities from zirconium salts.

The process is now being checked out in a pilot plant at USI's Cincinnati research laboratories. If it proves as good as it looks, the company will exercise its option to buy worldwide patent rights (Australia excluded), and the process will be used in the 2-million-lb./yr. plant USI is now building at Ashtabula, Ohio, to make nuclear-reactor-grade zirconium sponge (*Chementator,* June 1956, p. 108).

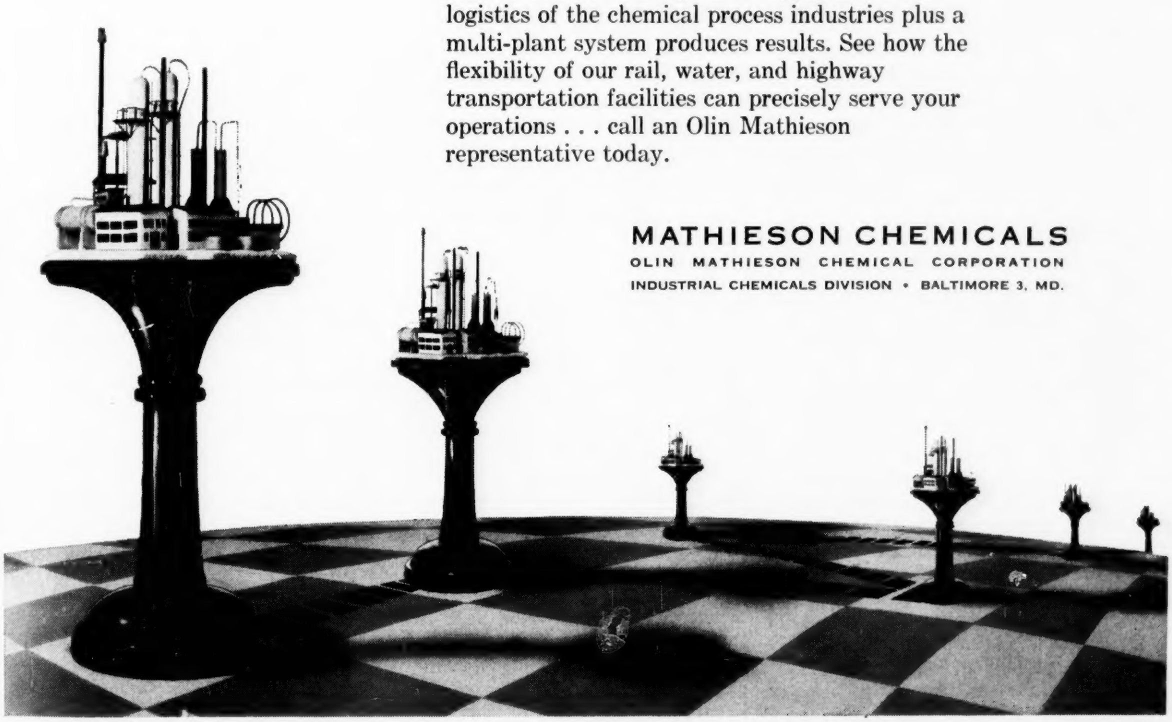
USI already plans to sell the sponge for $7/lb. on a spot basis and at lower prices to contract costumers, compared with present prices of $14/lb. and up. If the new separation method is successful, look for another drastic price cut.

The process, developed by Commonwealth Scientific and Industrial Research Organization, is reported to involve selective reduction of zirconium and hafnium tetrachlorides in a single step reaction with no added chemicals. Reaction products are said to be easily separated.

On the surface, this appears to be similar to the vapor-phase dechlorination method that representatives of the Indian Institute of Science described to the Geneva Atoms-for-Peace meeting in 1955. The Indians heat mixed chlorides with dry chlorine and air to selectively dechlorinate the zirconium. This appears in the residue as the dioxide, while hafnium remains in the vapor phase as the tetrachloride.

Although the reaction takes place in one step, on a commercial scale it is unlikely that sufficient separation will take place in a single stage. But chlorinating the dioxide residue and either sending it on to a second stage or recycling it to the first will further reduce hafnium content.

For more on DEVELOPMENTS.........114



New Plant Makes UO_2 Nuclear Fuel

Mallinckrodt's privately owned plant now turns out uranium oxide powder, enriched in U-235, for fabrication into ceramic or cermet reactor fuel elements.

With full credentials as one of the opening wedges putting nuclear reactor fuel manufacture into peace-time business, a commercial-scale, $750,000 plant for making enriched uranium dioxide has just been started up near Hematite, Mo., by Mallinckrodt Chemical Works.

Privately financed and operated, the new plant looks to commercial nuclear power as a market for its quantity output of two grades of U-235-enriched product: ceramic-type, for use in pellet-form fuel elements; sintered material, for matrix or cermet fuel elements.

▶**Lukewarm or Hot**—Plant can produce uranium dioxide in any desired degree of U-235 enrichment. Capacities range from hundreds of pounds per day of low-enriched (1 to 3% U-235) product to a few pounds per day of 90%-enriched product. All products can be tailor-made to meet individual customer specifications for particle size.

Sold as either brown powder or crystals for fabrication into fuel elements by the customer, Mallinckrodt has already shipped enriched UO_2 to General Electric (for use in a prototype nuclear power generator now under construction near San Francisco) and to Aerojet-General Nucleonics.* Additional product will be used in prototype work in connection with Commonwealth Edison's proposed $45-million nuclear power plant near Chicago.

Mallinckrodt's raw material, enriched uranium hexafluoride, comes from the Atomic Energy Commission, still the only supplier of raw material for atomic fuels (see p. 128).

▶**Process Problems Solved**—The company's manufacturing technique is not patterned after any established AEC process, nor has it previously been used in its present form.

Though based on classical principles of chemistry and physics, the three-step process required considerable engineering development work before commercialization. Carried on in a pilot plant at St. Louis, this work centered on creating rigid controls over process conditions during the first step—hydrolysis of uranium hexafluoride to yield ammonium diuranate. For this stage determines the final shape and size of uranium dioxide crystals.

UF_6, heated with an electric blanket in shipping cylinders as it comes from AEC's gaseous diffusion plant at Oak Ridge, Tenn., vaporizes through pig-tail pipes into a reaction tank containing water. The UF_6 rapidly hydrolyzes into HF and uranyl fluoride. Addition of aqua ammonia then precipitates uranium as ammonium diuranate.

▶**Conversion to Oxide**—Ammonium diuranate is filtered and transferred to pans for drying in electric ovens. Dried salt is then heated to 600 C. in an electric furnace, is thermally decomposed to black oxide (U_3O_8) by pyrohydrolysis in the presence of steam.

After drying, the U_3O_8 is reduced with hydrogen at high temperatures to give UO_2. Uranium dioxide made this way is suitable for use in pellet form.

One more step is required for modifying UO_2 that is to be used in matrix fuel elements. A high-temperature sintering operation converts small crystals to large, hard ones by means of compression and heating to 1,700 C. This is done in an electric furnace under an atmosphere of hydrogen.

Finished products of both the ceramic and sintered crystals are ground and sieved to customers' specifications before they are shipped.

▶**Safety Problems Solved**—Company engineers have developed a number of elaborate precautions that permit safe control of potential hazards. For example, all exhaust air is put through special dust collectors to insure complete removal of uranium dust, not only for product recovery but also to make certain that surrounding air will not be contaminated. All process water is thoroughly treated prior to discharge into the neighboring stream to remove all objectionable chemicals, and a special sanitary sewage treatment plant has been installed to prevent stream pollution.

The possibility of cross-contamination has been virtually eliminated by dividing the processing area into bays, each of which is restricted to the manufacture of material of a specific degree of enrichment.

Dusty operations are carried out in completely enclosed "dry boxes." These boxes are independent of the general room-ventilating system and are operated at slightly reduced pressure so that air leaks into the box rather than out.

Another safety measure is in washing the workers' clothing. Uniforms are prewashed by the company before being sent out for laundering. If the wash water is relatively high in uranium, the clothing is washed again.

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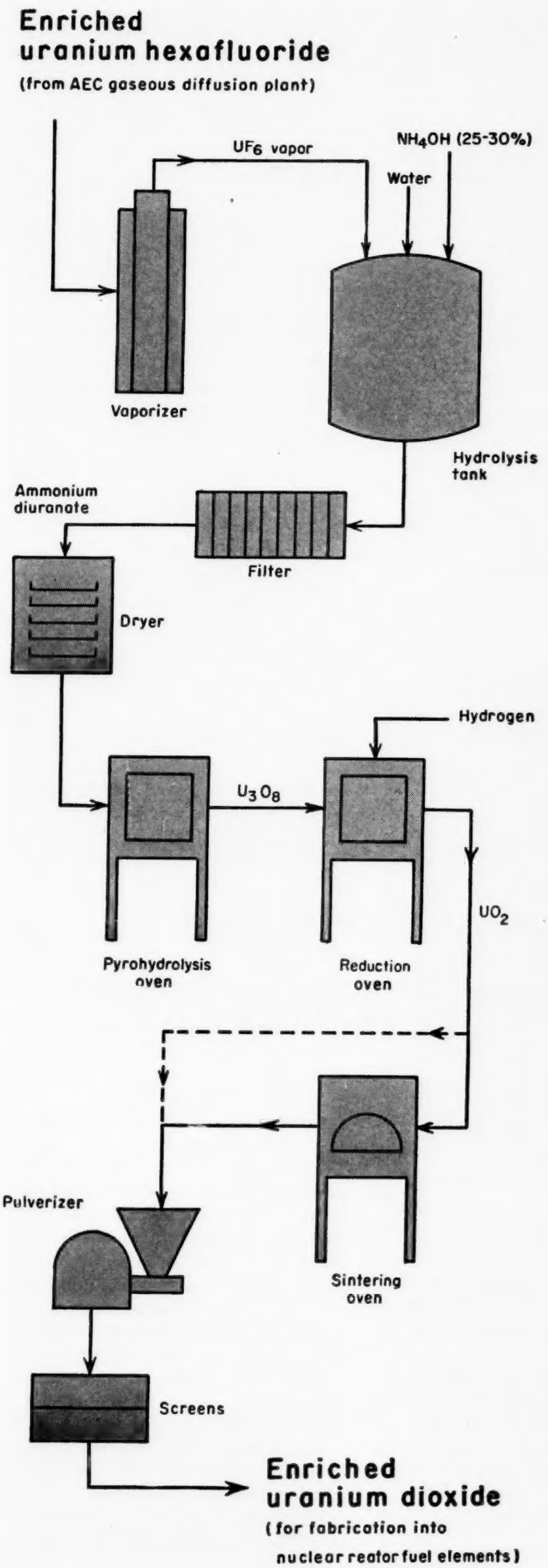
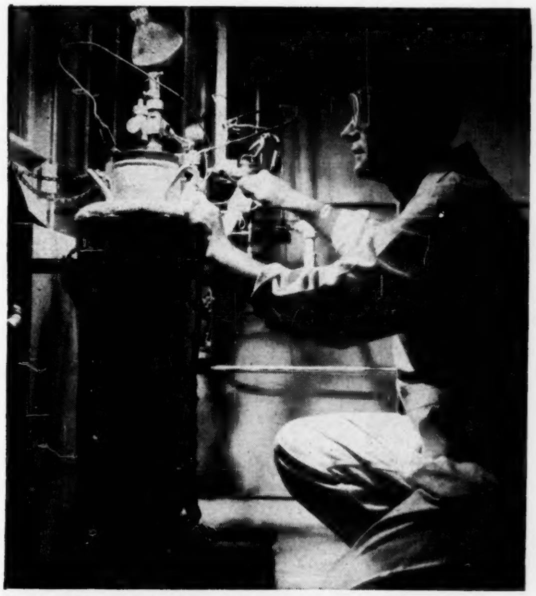
*AGN's first mass-produced training and research reactor, the AGN 201, went critical on October 25 with 656 grams of U-235 in the form of 20%-enriched uranium oxide.




URANIUM HEXAFLUORIDE VAPORIZER


DECOMPOSITION KILN


GRINDING AND SCREENING AREA

Electric-Furnace Plant Starts Metal Processing

Strategic-Udy Metallurgical and Chemical Processes, Ltd., has started up a prototype low-cost electric-furnace plant at Niagara Falls, Ont.

Initially, the plant is processing low-grade manganese ore from 150-million-ton New Brunswick deposits owned by parent company, Strategic Materials Corp. This operation will provide engineering design and operating cost data which SUMAC will apply in planning a commercial plant at Woodstock, N. B. Construction of this larger plant, which will produce 75,000 tons/yr. of ferromanganese, is expected to begin shortly.

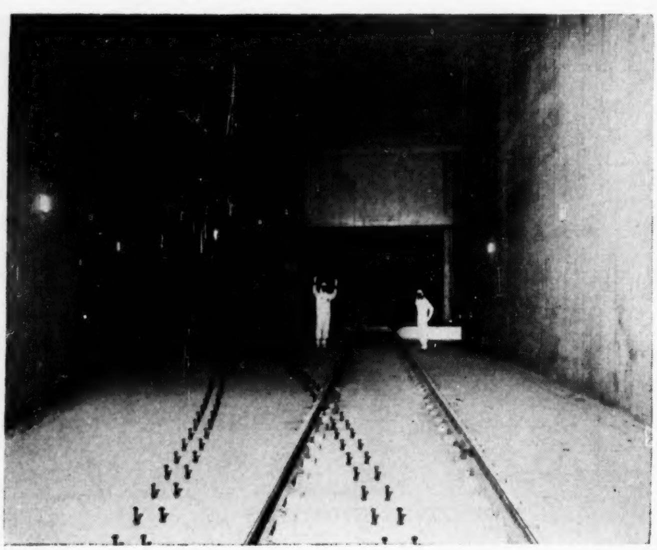
Following the test run of its own manganese ore in the prototype plant, the company will run other manganese ores while the furnace is still set up to handle this particular process. The furnace then can be adapted to processing high-iron-content aluminum ores, titaniferous magnetite, chromium ores and others for which Strategic-Udy has processes requiring electric-furnace treatment.

West May Get Fresh Water From Sea Via Solar Still

A pilot sea water conversion plant based on a solar still may soon be operating in San Diego, Calif. Plans to produce 500 gal./day of fresh water await final approval of the Interior Dept.'s salt water conversion program and the San Diego city council.

Still would consist of a series of saucer-shaped concrete slabs covered with glass. Sun's radiation is absorbed in the shallow basins containing salt water. The water, at temperatures from 100 to 150 F., evaporates slowly into the air space and condenses on the air-cooled cover glasses. Distilled water then collects in channels at the lower edges of the glass covers.

Although this process has been known for a century, substantial development has taken place only within the last few years (*Chem. Eng.*, Sept. 1956, p. 177).



Tunnel Swallows Outcast Equipment

Disposal problem presented by worn equipment, too radioactively "hot" to be repaired and too heavy to be hauled away for burial, has been solved by construction of this 500-ft. tunnel-tomb at General Electric's Hanford, Wash., plant. Outcast equipment aboard a railroad car will be rolled into the rail-equipped tunnel. Closing of concrete, water-filled radiation barrier gate will safely entomb the car and its highly contaminated cargo.

The tunnel, 19 ft. high and 23 ft. wide, will hold 12 loaded flat cars. It is an underground extension of a new chemical separations plant where uranium fuel is processed after being irradiated in nuclear reactors.

Round of Expansions For Polyols

To meet the increasing demand for trimethylol propane in the rapidly growing polyurethane plastics and coating fields, Celanese has started building a new production unit at its Bishop, Tex., plant. Plans to build a 10-million-lb./yr. pentaerythritol plant in Dominguez, Calif., have been announced by Borden Co. And Merck & Co. has announced plans to become the nation's second producer of sorbitol; only producer thus far has been Atlas Powder Co.

To be completed by year's end, the Celanese trimethylol propane unit will utilize special company-developed aldoling processes and will greatly expand capacity for polyol and aldol production which began a year ago with startup of a semiworks unit.

Borden's facilities will mark the company's entry into pentaerythritol production and will produce, in addition, 40 million lb./yr. of formaldehyde. PE production will be via a new company-developed process said to yield a high-quality product free of deleterious mineral impurities found in normal technical-grade PE. It also features single-plant integration with formaldehyde production. For formaldehyde, Borden will use a new high-efficiency, high-yield Karl Fischer process for which the company has exclusive U. S. rights.

Merck's sorbitol production will be at its Danville, Pa., plant.

Now! Elemental Fluorine Available in Bulk
. . . and in Easy-To-Use Liquid Form

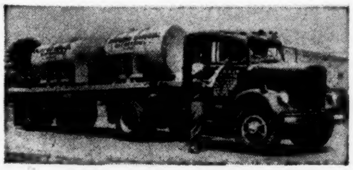
GENERAL CHEMICAL Announces

TONNAGE SHIPMENTS OF Liquid Fluorine!

Large scale transportation of elemental fluorine is now possible and practical. This most reactive of all elements has been tamed and harnessed by General Chemical for industrial use . . . by anyone, anywhere . . . without requiring captive plant facilities.

As a result of General Chemical research, fluorine can now be stored, transported and handled directly *as a liquid in tank-truck tonnages.* Large quantities can be used with far greater economy, simplicity and safety than has ever been possible with the normally gaseous form.

If your production or research program involves fluorine or fluorine-supplying chemicals, look into General's liquid fluorine development without delay. It makes possible new approaches to your problems that were impossible before. As a first step, write today for our comprehensive new technical bulletin, "Fluorine." It contains a wealth of helpful data.



Product Development Department

GENERAL CHEMICAL DIVISION

ALLIED CHEMICAL & DYE CORPORATION

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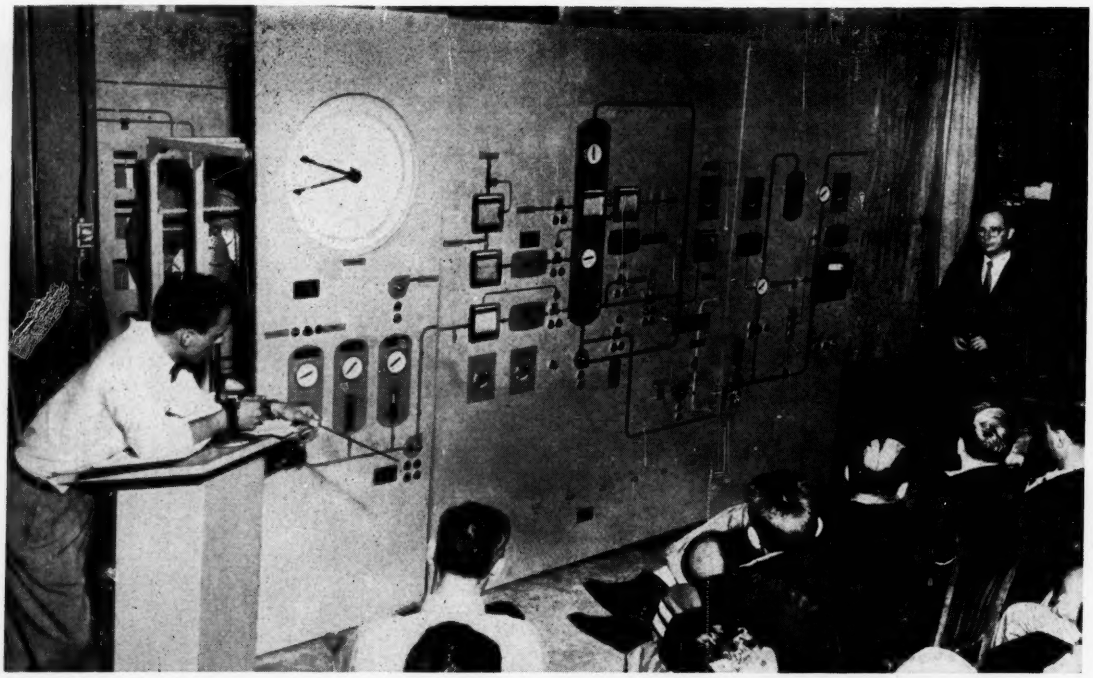
Basic Chemicals for American Industry



INSTRUCTOR points out to class what will happen to process variables under an assumed set of conditions.

Trainees Learn Fast in Dummy Control Room

Process simulator gives operating crew at new Du Pont plant the chance to profit by actual operating "experience" even while the plant is being built.

While everyone agrees that experience is the best teacher, it is often a costly process, especially when starting up a complex new chemical process with an operating crew recruited from other occupations.

Du Pont has now found a way to teach chemical process operators by experience, at the same time avoiding the costs of spoiled products and plant outage. The training method involves use of a "process simulator," such as the one shown in the above picture.

Engineering specialists, working with plant production men, first put this idea to work in 1955, while construction was under way on a new plant which was to use a new process. Outstanding success with this technique of operator training has led to its further use in the company, employing various modifications of the original simulator design.*

▶**Dummy Control Room**—The process simulator consists of a dummy control panel resembling in appearance that which will be used in the production unit under construction. For convenience and economy, the simulator panel is made of a lightweight material, such as Masonite.

Du Pont's first simulator—representing more than 100 ft. of panel—used for its instruments the actual front portions of indicators, recorders and other control-room devices. Each of the simulator instruments had a movable pen or indicator, just as in the real instrument. The pen or indicator was moved by hand and would stay in whatever position it was placed.

Electrical circuits were made functional, simulating the pushbuttons, alarm horns, safety interlocks and indicator lights to be used in actual operations.

In order to provide flexibility, portability and economy, Du Pont engineers, working with the Carmody Corp. (Buffalo, N. Y., builder of simulators for training military personnel), decided to limit the training to only a portion of the control room at any one time. Thus they had to provide only as many simulated instruments as necessary to equip any three adjacent sections of the control panel. In all cases this permitted demonstration of a complete step of the process.

▶**How Simulator Is Used**—The instructor sets up any given problem on the simulator, explains it fully to the class and illustrates the way in which the process would react from that point on. Next step in instruction

* It was in 1955, also, that Hammermill Paper Co. used a similar approach in training operators for its new Neutracel pulp plant at Erie, Pa.

Weed killers?

Oil additives?

What's <u>your</u> need for top quality Phenol?

● *"Phenol is the backbone of the thermosetting plastics industry."*

But the wide range of *other* products which use some form of phenol is indicated by the illustrations here.

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With RCI PHENOL you can be sure of quality control because *Reichhold not only sells its phenol but uses it.* RCI produces phenolic resins for everything from high pressure laminates to plywood glues.

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is to have each student "operate" the process on the simulator.

Finally—and most important—the instructor checks out how well the student understands the process by creating emergency conditions on the simulator. Under such conditions the student may get excited and forget all that he has been told. This type of training, then, helps develop confidence and dependability and thus assures having the right men in the plant control room.

▶ **Pays Its Way**—Once the simulator was on hand and put into use, early objections to its expense quickly disappeared. These are some of the benefits ascribed to its use:

- Potential operators become familiar with the control room of the plant before the control room has even been built.
- Students can develop skill in operation of the various devices in the control room without having to worry about spoiling one pound of product.
- Conditions which could lead to accidents or malfunctioning of the process can be illustrated and corrective means demonstrated.
- The simulator provides a check on the functional design of the plant. Its use has led to discovery of several points of inconsistency in plant design.

▶ **Training Cost**—What does it cost to obtain these benefits? Over-all training cost, using the simulator, is less than that of conventional training programs. Larger groups can be handled (10-15 people), training is more effective and training time is compressed.

Today's approach to simulator design is to use photographs of instruments, rather than actual instruments, mounted on the panel. Pointers can be simply pinned on the panel. Miniature push buttons, switches and pilot lights are used, rather than industrial type.†

These ideas can reduce costs to the point where it's economically feasible to build a simulator for an entire control room at once, rather than having to break it down into small sections.

▶ **Future Designs**—Full potential of the simulator is yet to be developed, Du Pont feels. A recently built unit has an instructor's console, from which the instructor can remotely position the instrument pointers.

Ultimate in training aids would be a simulator incorporating an analog computer. The computer would automatically determine the results of any process upset in a manner analogous to functioning of the actual plant. This would eliminate the laborious, risky task of tracing cause and effect throughout a complex process during training sessions.

Components of such a simulator are already available and, some engineers believe, economic justification is just around the corner.

†This is essentially what Hammermill Paper did. Its simulator consisted of full-size plywood control boards with paper cutouts of the instruments.

Plant-Scale Tryout For Alumina From Clay

Anaconda Co. plans to build a $1-million pilot plant at Anaconda, Mont., to test a process for extracting alumina from native Idaho clays in Latah County deposits. Plant will produce 10 to 14 tons/day of alumina from about 50 tons of clay.

Process, while secret, is believed to be no radical departure from generally recognized methods, but an improvement over earlier processes combined with advanced techniques. Of process cost, Anaconda will say only that it is "competitive."

If successful, Anaconda believes the plant will mark the first industrial recovery of alumina from domestic clays, although virtually every major aluminum firm has tried to work out such a process.

Prime importance of the plant to Anaconda is raw-material proximity; a source of alumina lies within a few hundred miles of its Columbia Falls, Mont., aluminum plant. If the clay extraction process is successful, the company will build a clay processing plant near transportation in north-central Idaho or eastern Washington. The plant would be at least large enough to supply the 120,000 tons/yr. of alumina required at the reduction plant.

Convention Calendar

Society of Plastics Engineers, 13th annual National Technical Conference, St. Louis section, "Fifteen Years of Plastics Progress," Sheraton-Jefferson Hotel, St. Louis, Jan. 16-18.

Assn. for Applied Solar Energy, in conjunction with Arizona State College and University of Arizona, symposium on solar furnace design and operation, Hotel Westward Ho, Phoenix, Jan. 21-22.

Twelfth annual symposium on Instrumentation of the Process Industries, Texas A. & M. College, Memorial Student Center, College Station, Tex., Jan. 23-25.

Canadian Pulp & Paper Assn., annual meeting, symposia on all phases of pulp and paper manufacture, Mount Royal Hotel, Montreal, Jan. 23-25.

Eighth Plant Maintenance & Engineering Conference, concurrently with Plant Maintenance & Engineering Show, Public Auditorium, Cleveland, Jan. 28-31.

American Welding Society, Midwest Welding Conference, Chicago section with Armour Research Foundation, Illinois Tech Chemistry Bldg., Chicago, Jan. 30-31.

American Society for Engineering Education, ninth annual college-industry conference, University of California, Los Angeles, Jan. 30-31.

Southern California Meter Assn., sixth annual instrument short course, Los Angeles Harbor Junior College, Jan. 31-Feb. 1.

Society of the Plastics Industry, twelfth annual technical and management conference, reinforced plastics division, Edgewater Beach Hotel, Chicago, Feb. 5-7.

American Society of Heating and Air-Conditioning Engineers, 13th International Heating & Air Conditioning Exposition, International Amphitheatre, Chicago, Feb. 21-Mar. 1.

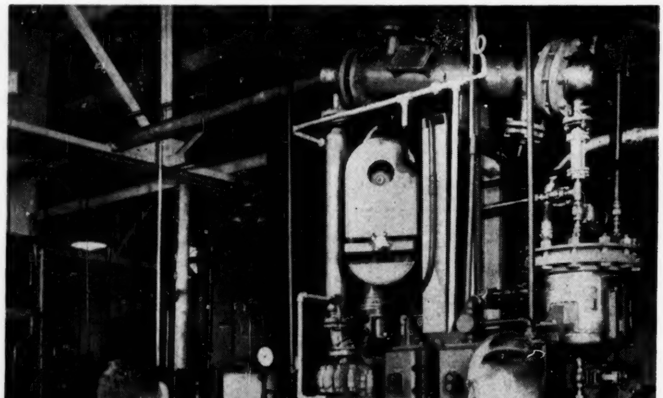
Polyethylene: High, Low, Medium and Irradiated

British Hydrocarbon Chemicals Ltd. has just announced plans for a 22-million-lb./yr. high-density polyethylene plant at Grangemouth, Scotland. At an existing plant in Tuscola, Ill., National Petro-Chemicals Corp. has added production of medium-density polyethylene to a 52-million-lb./yr. output of low-density product, which is, itself, due for a midyear hike to 100 million lb. And W. R. Grace has acquired both U. S. and world rights to a new process utilizing irradiation to modify and improve polyethylene (*Chem. Eng.*, Aug. 1956, p. 122), which was developed by Sequoia Process Corp., Redwood City, Calif.

British Hydrocarbon's plant will mark first use in Britain of Phillips' low-pressure process. Petrochemicals Ltd., a wholly owned subsidiary of Shell Chemical, holds exclusive British rights to the Ziegler process. Some months ago it announced that it was building a 2-million-lb./yr. Ziegler pilot plant.

Last February, Imperial Chemical Industries' patent for the manufacture of polyethylene by high-pressure polymerization of ethylene expired. ICI remains the sole producer in Britain, though two other companies have started building plants using the high-pressure process, which will be in operation by 1958.

Union Carbide has a 23-million-lb./yr. plant, estimated to cost more than $11.9 million, under construction at Grangemouth, and Monsanto Chemicals Ltd. has just started work on a 20-million-lb./yr. plant at Fawley as part of its $23.8-million petroleum chemical expansion program. ICI, whose output will shortly reach an annual rate of 114 million lb., is also engaged in a big program designed to raise its output of polyethylene from its Wilton works to 180 million lb./yr. by 1959. The ICI process requires some of the highest pressures ever used in the chemical industry.



Pilot Plant Spans Pharmaceutical Operations

Almost any operation in pharmaceutical manufacture can be performed in this new 4 x 9 x 2½-ft. pilot-plant unit designed for Lakeside Laboratories, Milwaukee, by Pfaudler Co. It can reflux, react, distill and handle quickly a host of functions. High-vacuum distillation is done at as low as 50 microns.

New Way to Profit From Waste Disposal

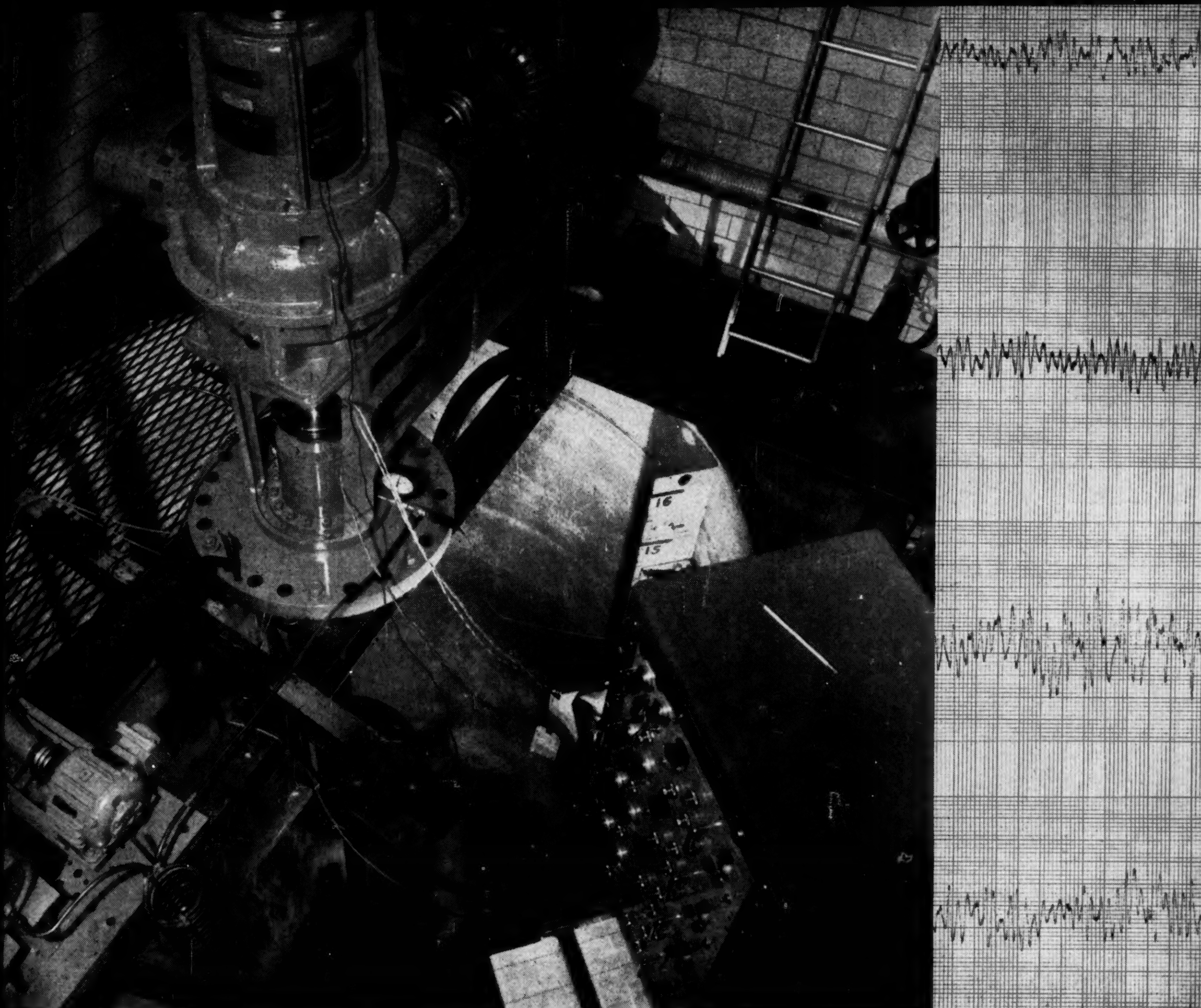
Silica recovered via a new collection unit installed at Ohio Ferro-Alloys Corp.'s Tacoma, Wash., plant will be bagged and sold to Kaiser Aluminum & Chemical Corp. for use in Kaiser's refractory plants in California and Ohio. The $600,000 bag-type dust and smoke collector will be capable of cleaning 500,000 cfm. through 4,500 bags alternately collecting and dumping 24 hours a day. Sublimed silica from the collectors will give added strength to Kaiser brick manufactured for the open-hearth and electric furnaces of the steel industry.

The Tacoma plant has two electric furnaces producing ferroalloys, principally silicon alloys, for the steel and aluminum industries. Collector is expected to capture virtually all smoke from the furnaces, formerly one of Tacoma's major air-pollution problems.

West Gains Strength In Polyethylene

Pacific Coast's first plant producing ethylene oxide, ethylene glycol and polyethylene has been started up by Carbide & Carbon at Torrance, Calif. Plant is adjacent to General Petroleum Co. refinery, its source of feed gas.

Feed for the 60-million-lb./yr. low-pressure (Ziegler) polyethylene plant planned for Los Angeles County as a joint venture of Brea Chemicals and Koppers will come from nearby Union Oil Co. facilities now under construction. To be completed early in 1958, Union Oil's unit will be capable of making 100 million lb./yr. of ethylene.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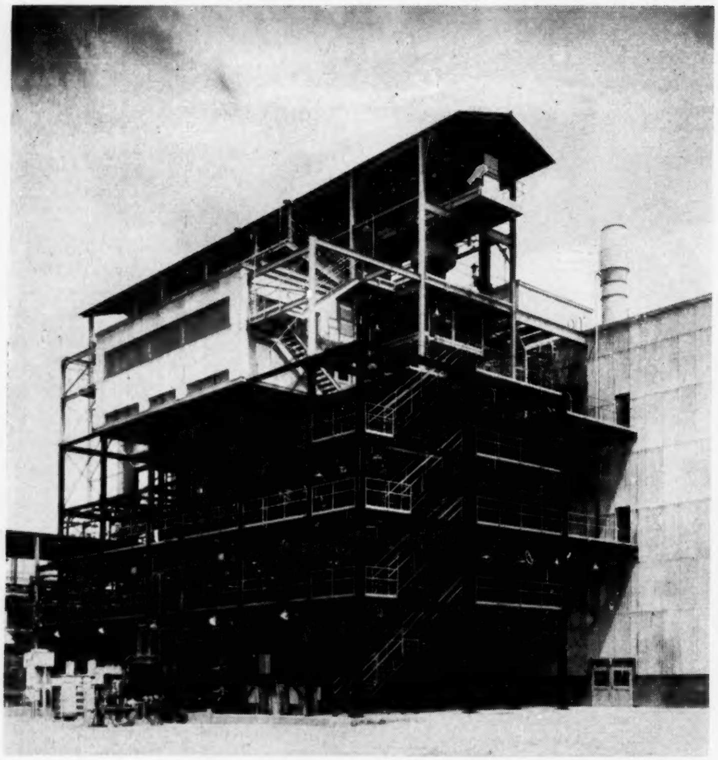


REVAMP of tricky chlorination process yields plenty of $TiCl_4$ as . . .

Ti Plant Hits Full Capacity

Cramet engineers chalk up admirable record in making the unusual transition from valve and bathtub manufacture to integrated titanium metal production.

Passing quietly through low and second gears since starting operations early in 1955, Cramet Inc. expects to shift its $28-million titanium metal plant at Chattanooga into high gear this month.

Rate of production last year was below the projected plant capacity of 6,000 tons/yr. One limitation on output has been availability of the titanium tetrachloride intermediate.

However, Cramet expects modifications now being made to the chlorination unit to bring plant output up to full rating. And studies now in progress could further boost capacity way beyond the 6,000-ton/yr. mark when the additional sponge is needed.

▶ **Record of Accomplishment**—Cramet's record takes on more luster when viewed in the light of other developments in the infant titanium industry.

The Chattanooga plant is the first titanium plant to be built from scratch which produces its own tetrachloride. Du Pont's titanium plant at Newport, Del., gets it $TiCl_4$ from another production unit at Edge Moor, Del.; the latter was designed primarily for manufacture of TiO_2 pigment. Although Titanium Metals Corp. operates an integrated plant at Henderson, Nev., much of the plant was built during World War II for production of magnesium. And Electromet's new plant at Ashtabula, Ohio, depends on an outside source of $TiCl_4$.

Cramet's vice president and general manager, P. W. Bakarian, is especially proud of the firm's progress in product quality. He points out that quality of Cramet's titanium sponge, after only 18 months of operating experience, is highly satisfactory.

▶ **Developing the Know-How**—Although Cramet is now owned jointly by Crane Co. and Republic Steel, the plant was physically completed and in operation before Republic bought half interest in June 1956.

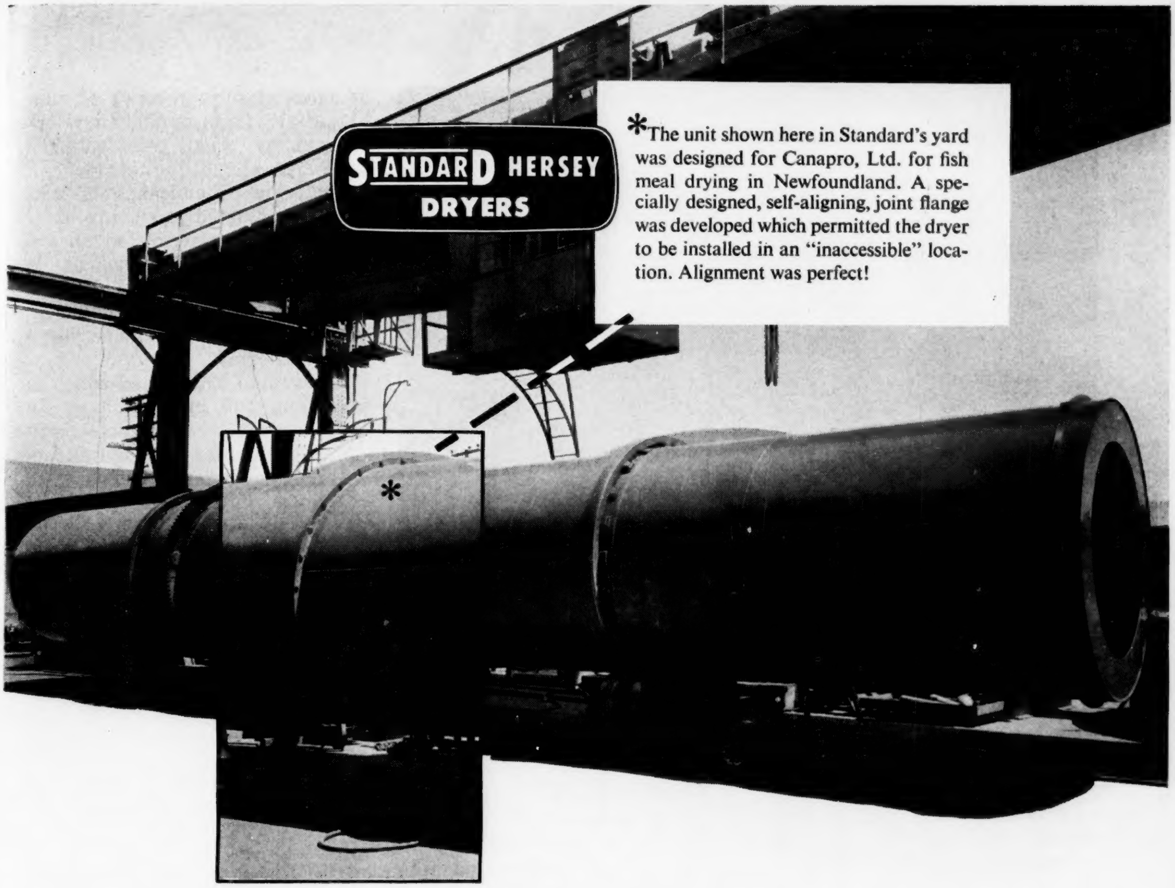
How, then, did Crane, expert in making valves and bathtubs, get into the titanium business?

Crane acquired basic know-how in $TiCl_4$ production by purchasing licenses under French and Swiss patents. Crane put metal production processes through extensive pilot-plant paces, first in Chicago, later at Chattanooga. Valuable contributions were also made in design and construction of the plant by Vitro Corp. and Turner Construction Co.

Bakarian places heavy emphasis, too, on the accomplishments of his operating staff at Chattanooga. Technical director is Julian Glasser, who did titanium research at Armour Research Foundation before joining Crane in 1953. Bakarian's immediate technical assistant is Frank Wartman, a pioneer investigator in titanium technology with the Bureau of Mines for many years.

▶ **Economic Picture**—Cramet's Chattanooga location capitalizes on ready availability of electric power (TVA's Chickamauga Dam is nearby), natural gas, water and labor. The company also anticipates that, eventually, raw materials coming in and products moving out will be shipped via the Chickamauga River, as well as by rail and truck.

Production to date has been based on rutile imported from Australia. However, Heavy Minerals Co.—an affiliate of Crane and Vitro—has developed domestic sources of rutile at Aiken, S. C., and Republic is exploring



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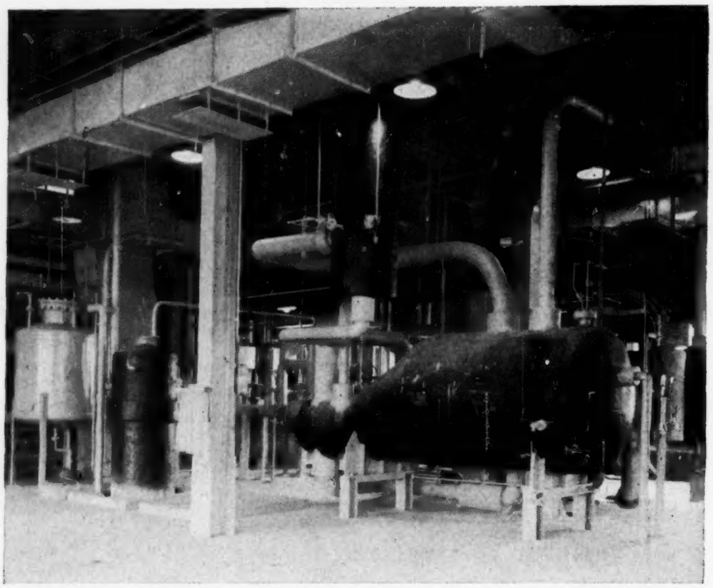


REBOILER and distilling column help purify titanium tetrachloride.

rutile deposits in southwest Mexico.

Republic's entry on the Cramet scene also brought with it well-developed skills in titanium melting and forming and a selling organization for titanium mill products.

▶**Process Highlights** — Rutile and coke are ground, mixed and briquetted to form the charge for the chlorination furnaces. The shaft-type chlorinators operate with continuous feed of briquettes and chlorine and periodic removal of ash. In condensing the chlorination products, liquid $TiCl_4$ circulates through the condensing system to flush solids through and prevent plugging of the tubes.

Solids, such as ferric chloride, are removed, and the liquid is then fractionally distilled to produce high-purity $TiCl_4$.

Magnesium is the reducing agent in the modified Kroll process. Byproduct $MgCl_2$ is tapped as liquid from the reduction pots. Residual $MgCl_2$ and magnesium are removed from the titanium sponge by vacuum distillation. Cramet has developed a special technique for removing the sponge from the pots, thereby avoiding the need for chipping the sponge out on a boring mill.

Process heat for reduction and vacuum distillation steps is supplied by electrical-resistance furnaces.

▶**What's Ahead** — Now that some of the more pressing production problems are in the past, Cramet's engineers are pushing on to longer-range studies.

In the chlorination area, Cramet is looking at alternative raw materials, such as ilmenites and slags. Also on the agenda are studies of improved chlorination techniques.

Other studies involve disposal of byproduct magnesium chloride. Recycling through a captive magnesium plant would be one possibility; another would be conversion into other products, such as magnesium oxide and HCl (see *Chem Eng.*, Aug. 1956, pp. 346-9).

Synthetic Rubber Entries Pile Up in U.K.

British Geon, subsidiary of Distillers Co. Ltd., will manufacture nitrile rubbers at a new plant under construction at Glamorganshire, England. Distillers is associated with B. F. Goodrich in the new venture, as well as in the manufacture of polyvinyl chloride plastics, already under way at the same site.

Announcement of this facility follows closely on news of substantial synthetic rubber developments by other chemical and allied groups in Britain:

Imperial Chemical Industries has just started producing butadiene-based materials at an annual rate of 10,000 tons at its \$11.2-million plant at Wilton. ICI's synthetics will include special-purpose butadiene-acrylonitrile materials.

Monsanto Chemicals, which is reaching full production at its \$1.4-million Newport plant, will initially market only butadiene-styrene copolymers, but hopes to produce butadiene-acrylonitrile materials later on.

General-purpose rubbers will be produced at Dunlop Rubber Co.'s experimental plant, and at the Fawley plant of the International Synthetic Rubber Co. when the latter comes into operation in about two years. This consortium was formed late in 1955 by Dunlop, Goodyear, Firestone and Michelin to handle a \$19.6-million project for synthetic rubber production in Britain.

Battelle Completes Center For Atomic Research

With the recent startup of its 1,000-kw., \$75,000 "pool-type" reactor at Columbus, Ohio, Battelle completed the nation's first privately owned nuclear research center.

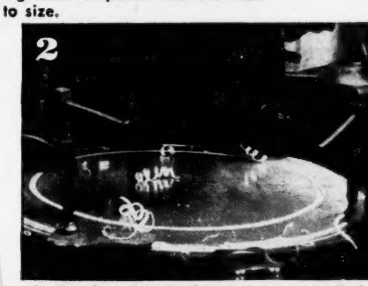
Designed exclusively for research purposes, the new reactor will be applied to problems on the chemistry of petroleum, sterilization of pharmaceutical products, preservation of agricultural goods and improvement of numerous chemical products and processes. The center, built entirely with Battelle funds, is at liberty to contract with private industry for nuclear research without government security restrictions.

Huge Ultrasonic Cleaner For Atomic Reactor

Believed to be the largest of its kind in the world, an ultrasonic cleaning and degreasing system powered by high-frequency generators totaling 20

Steps to a CB&I built Aluminum Tank

Aluminum plates in the plant receiving yard. From here, they go to the layout shop for marking from templates and are then trimmed to size.

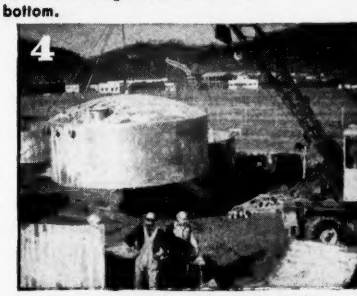


In the shop the aluminum plates are rolled to the required shape and fittings and connections are machined to the proper dimensions.

This view inside the tank shows the lower ring of the shell being welded to the aluminum bottom.

• These photographs show some of the operations necessary to fabricate and erect six aluminum tanks, 17 ft. in diam. by 17 ft. 9 in. high. They were built by Chicago Bridge and Iron Company for the Carbide and Carbon Chemical Corporation at Institute, West Virginia.

CB&I is a leader in the field of specialized welded plate structures with more than 65 years of experience. Their four plants have complete facilities for designing, fabricating and erecting steel and other metal plate structures to the most exacting requirements. When you plan . . . plan with CB&I. Write our nearest office for further information.



Above: The top ring, roof and fittings, after being welded together are lifted into place as a unit.
Below: Field erection is complete and the tanks have been inspected and tested.

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
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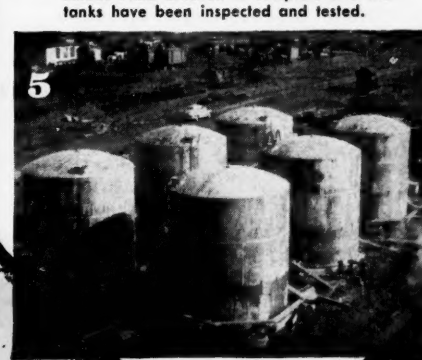
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.



kw. has been delivered to an Atomic Energy Commission facility by Acoustica Associates, Glenwood Landing, N. Y. It microscopically cleans parts of critical importance to AEC in a fraction of the time required by conventional methods.

Hundreds of above "audible sound" generating transducers are energized to irradiate materials being processed *en masse.* Ultrasonic energy developed creates explosive forces in the cleaning bath as a result of the collapse and formation of millions of entrapped vapor bubbles at the rate of many thousand times per second. These forces eliminate surface tension binding soils and contaminants to various parts of the materials processed. Scrubbing action of the ultrasonically agitated solution flushes impurities from the entire surface of the material.

Computer Speeds Piping System Design

Cut from a month to an hour: Time for complex computations to avoid destructive stresses in high-temperature piping.

A new method for coding piping design data which puts them in form suitable for calculation by digital computers has been developed by Blaw-Knox Co.'s power piping division. Called the "6x6 flexibility matrix" method, it permits a Univac to run off in one hour complex calculations providing for safe, low-maintenance high-temperature piping systems which formerly took skilled stress analysts a month or more to complete.

Dramatizing the value Blaw-Knox places on the method, it took the firm 18 months to develop it via a joint research project with Arthur D. Little, Inc. Design problems posed by high-temperature piping, involving thermal expansion of metals under today's requirements of increasingly high temperatures and pressures, are among the most complex that engineers are called upon to solve. Because the "classical approach" to these problems was not well adapted to machine computation, basic principles of stress calculations were re-examined in order to obtain results quickly and accurately via an electronic "brain."

High accuracy of the computations is indicated by the fact that all results are carried to six significant figures. Inconsistencies in the input data are detected by the machine; it will inform the operator of the error and substitute the correct dimension automatically. An extra advantage of the new design method is that, when it is necessary to change one component, the additional calculation is confined to this member instead of requiring, as before, a complete recalculation of the whole system.

Data that are fed into the machine consist only of dimensions that can be taken easily from an isometric drawing of the piping system and a few physical properties of the pipe material. These data are first tabulated on simple forms, from which the figures can be fed readily on to a suitable input medium, such as magnetic tape.

The method is available for use by consulting engineers, companies and individuals responsible for the design of power piping systems.

Industry Group To Build Reactor

Ten large U. S. companies have formed a new company, Industrial Reactor Laboratories, Inc., to build and operate a privately owned nuclear reactor for industrial research in atomic energy at Plainsboro, N. J.

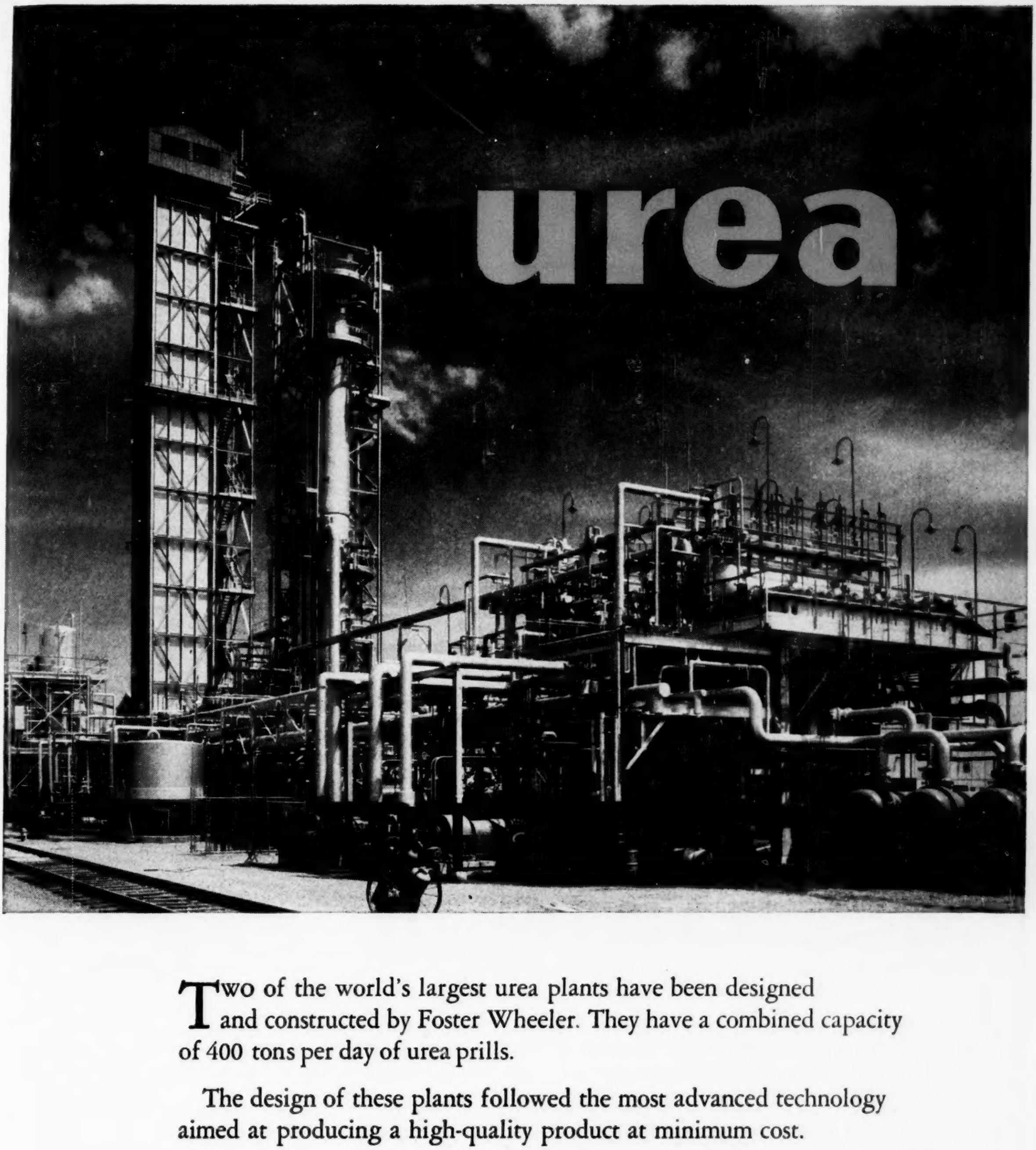
Participants are: Atlas Powder; AMF Atomics; American Tobacco; Continental Can; Corning Glass; National Distillers; National Lead; RCA; Socony Mobil; U. S. Rubber. New company's board of directors will be headed by Gen. Walter Bedell Smith, president.

First nuclear reactor to be built by an industrial firm strictly for its own research use has been announced by Westinghouse Electric Corp. It will be located near Pittsburgh, Pa., and will be completed in about two years.

First Private Output Set for Hexafluoride

AEC has approved a proposal of Allied's General Chemical Div. to build the first privately owned and operated facilities for production of refined uranium salts.

To be in operation by 1959, plant will use a new process which bypasses refining step as performed in AEC plants. Purification will be obtained by distillation of uranium hexafluoride.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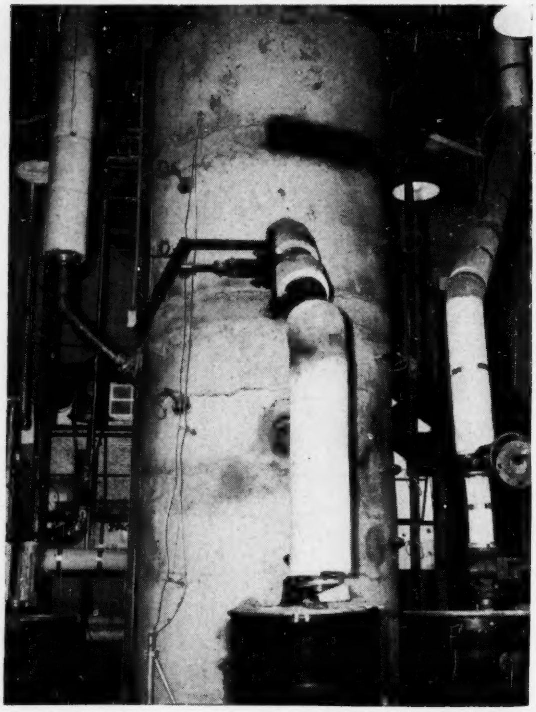
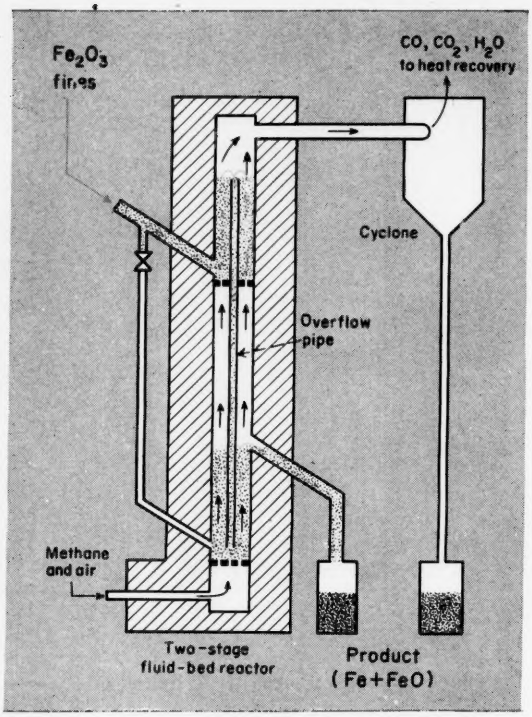




PILOT UNIT operated by Arthur D. Little is 30 ft. high, uses two reaction stages, as . . .

Methane Reduces Iron Ore in Fluid Bed

Although the blast furnace is here to stay, iron and steel men are attracted by the versatile talents possessed by this new approach to iron ore reduction.

The fluidized-solids technique is now being groomed for iron ore reduction—potentially one of the juiciest roles of its already-brilliant career.

At the Acorn Park laboratories of Arthur D. Little, Inc., Cambridge, Mass., the pilot-scale reactor shown above is reducing iron ore fines with methane at 1,550-1,650 F. Product is a powdery mixture of Fe and FeO. While not a true sponge iron, this mixture is excellent feed for either the electric furnace or the open hearth—although it would be necessary to compact it by rolling before using it as open-hearth feed.

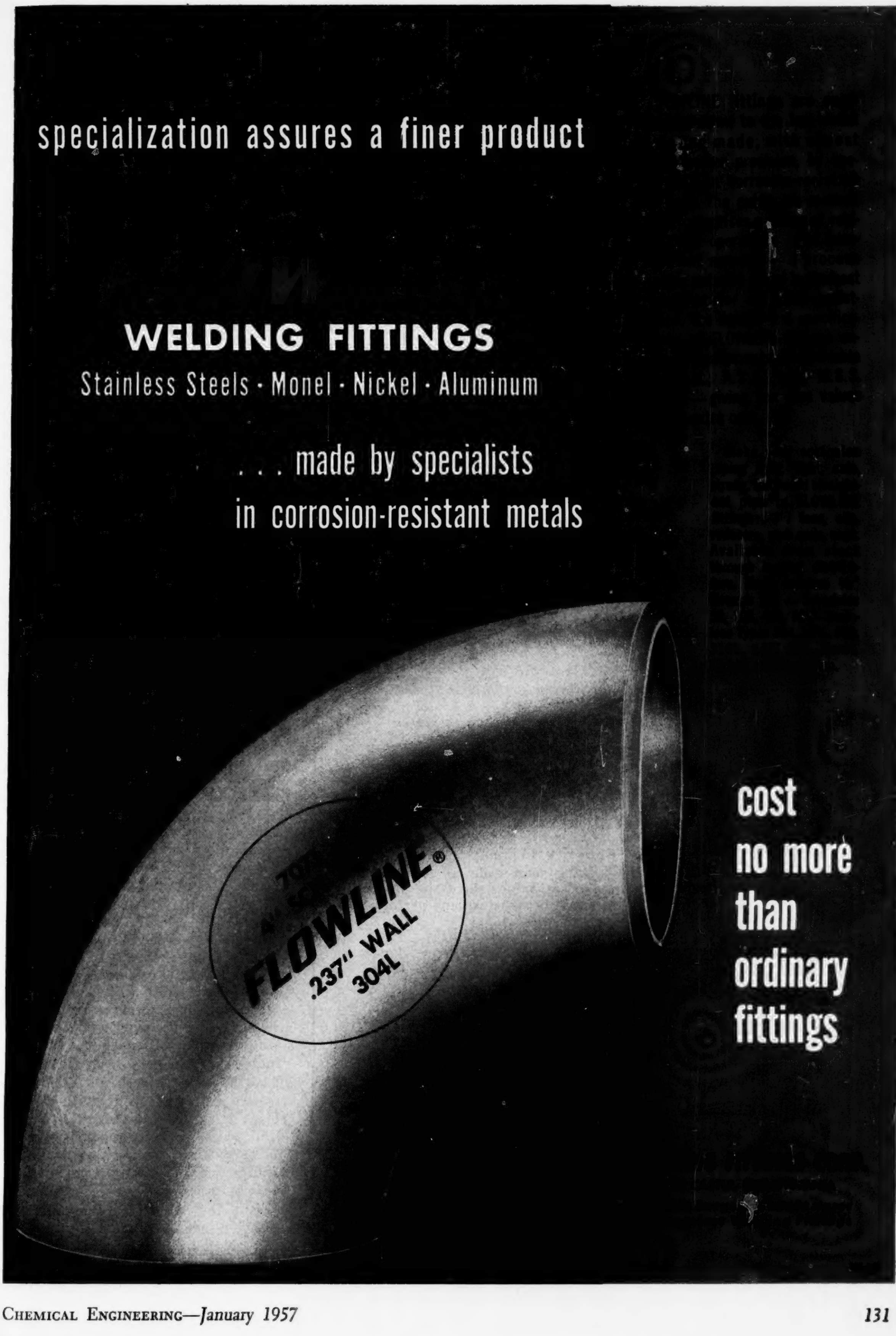
Devised by MIT's Warren K. Lewis for Esso Research & Engineering, this process is of special interest to chemical engineers because it is probably the only completely continuous process for iron ore reduction.

▶**Two More in the Wings**—There are at least two other fluid-bed processes now vying for industry attention:

- Hydrocarbon Research, Inc., and Bethlehem Steel have jointly developed a process (*Chem. Eng.*, May 1956, p. 110) that uses hydrogen from a partial-oxidation unit to reduce iron ore fines at about 900 F. and 400 psi.
- United States Steel is studying a process (*Chem. Eng.*, Nov. 1956, p. 104) that also uses hydrogen, but employs higher temperatures and lower pressures (1,100-1,700 F. and 15-30 psi.). USS is also studying reduction with mixtures of hydrogen and carbon monoxide.

▶**Continuous Performance**—In ADL's new pilot plant, a multistage fluid-bed reactor takes iron ore from a nearby steel mill, screens out and rejects particles over 8 mesh. (While ADL screens the ore just as it comes in and sends back oversize particles, a commercial plant would use crushers to produce fines purposely.) Powdery Fe_2O_3 goes to the upper "bunk" of the present two-bed reactor, a CO_2-CO-H_2O-H_2 mixture, is partially reduced to Fe_3O_4, FeO, metallic iron.

The fluidized mass in the top bed spills into an overflow pipe and drops to the bottom of the lower bed. Heat input to this bed is maintained by burning some of the methane with air. This generates sufficient heat to crack much of the remaining methane, with the metallic iron in the bed serving as catalyst. Cracked gases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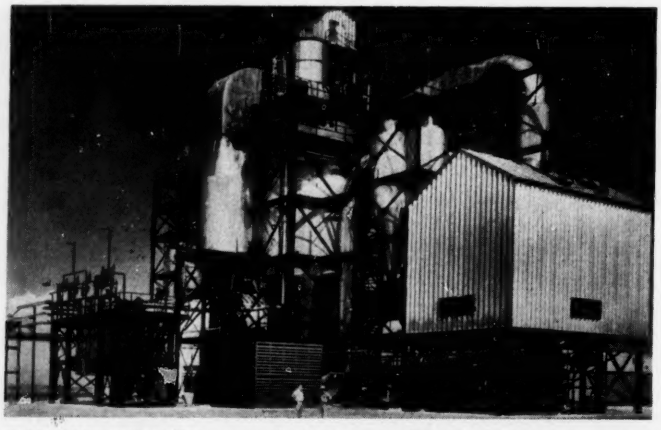
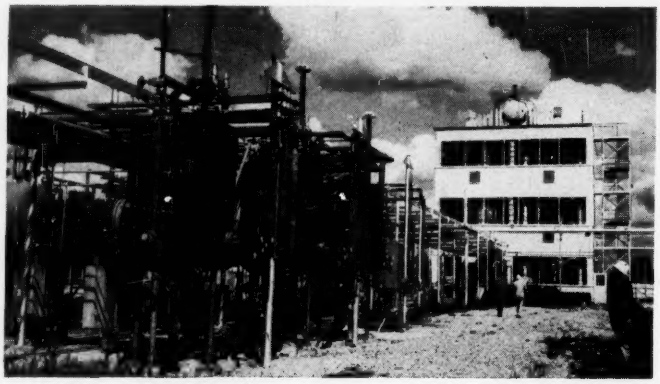
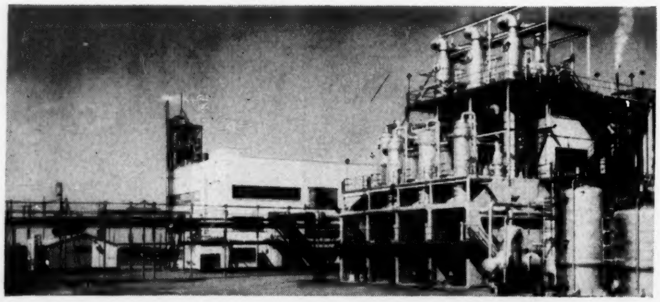
Year-End Harvest: Crop of New Plants



INSTANT STARCH, precooked, is spray-dried in all-stainless steel chamber, at new Corpus Christi, Tex., plant of Corn Products Refining Co. This is new use for spray drying.



NATURAL RUBBER is now being man-made at Goodrich-Gulf Chemicals' new pilot plant at Avon Lake, Ohio. Product is similar to tree rubber, both in structure and performance.



HYDROGEN PEROXIDE, via a new company-developed, nonelectrolytic process involving chemical oxidation, comes from Syracuse, N. Y., unit just opened by Allied Chemical & Dye's Solvay Process Div.

combine with oxygen in the FeO from the top bed to produce more metallic iron, as well as CO_2, CO and H_2O gases.

Iron powder, containing 5-30% FeO, leaves the reactor at the top of the lower bed.

▶ **A Balancing Act**—This reduction reaction is highly endothermic, and it is important that sufficient heat be generated in the bottom bed to support the reducing reaction. Preheating the methane and air with off-gases from the upper bed helps supply this heat.

This delicate heat balance in the reactor leads to processing problems. FeO is highly reactive with other oxides at the temperatures present in the reactor and could cause sticking in the bed and loss of fluidization.

Hydrocarbon Research, recognizing this problem, uses much lower temperatures (about 900 F.) in its reactor. But the slow reduction rate in this temperature range requires HRI to use 400-psi. pressures.

Prof. Lewis's experimentation showed that limiting the amount of FeO in the bed to 5-30%—by carefully controlling the CO_2-CO and H_2O-H_2 ratios and keeping reaction temperatures below 1,740 F.—minimized this sticking.

For ADL, the delicate heat balance has posed another problem. The pilot reactor (30 ft. high and 45 in. O.D.) is so heavily insulated that inside bed diameters are only about 12 in., but heat losses are still a severe problem. Fortunately, this will be essentially no problem in a commercial-scale reactor, since the volume-surface area ratio won't be as critical.

▶ **Won't Upstage Blast Furnace**—Even if the fluidized-solids technique plays a role in iron ore reduction, don't expect it to upstage the blast furnace, the steel industry's star performer for the past six centuries. Admittedly, critics can find fault with the blast furnace's lack of versatility, limited as it is to appearing in those areas blessed with an abundance of coking coal, and only in large-scale installations.

But few dispute its mastery over its lines—economically turning acres of ore into rivers of pig iron. (*Continued*)

the Sharples SUPER CLASSIFIER

Polyvinyl chloride . . . cement . . . barium sulphate . . . talc . . . sodium bicarbonate . . . ion exchange resins . . . zinc sulphide . . . iron oxide . . . flour . . . gypsum . . . uranium sandstone . . . fullers earth . . . these are but a few of the many dry powders which have been satisfactorily classified in the Sharples mill-size customer demonstration plant.

Now for the first time, there is available to industry a Super Classifier that provides ultra-sharp separations at high capacity, regardless of feed rate or size distribution in the feed—plus product recovery (yield) considerably higher than by any other means.

The Sharples customer demonstration plant is in all respects a full-scale commercial size classification plant capable of running continuously from 1,000 lbs. to 3,000 lbs. of product per hour. *Test results, therefore, are direct, require no extrapolation, and are precisely those obtainable from a Super Classifier of any capacity up to approx. 30,000 lbs. per hour.*

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The fluid bed's versatility is a virtue that can't be ignored, however, and its backers expect to catch the steel industry's eye with these talents:

• Can be used wherever natural gas can be supplied.

• May be economical in small units. (The blast furnace has to be huge to be economical.)

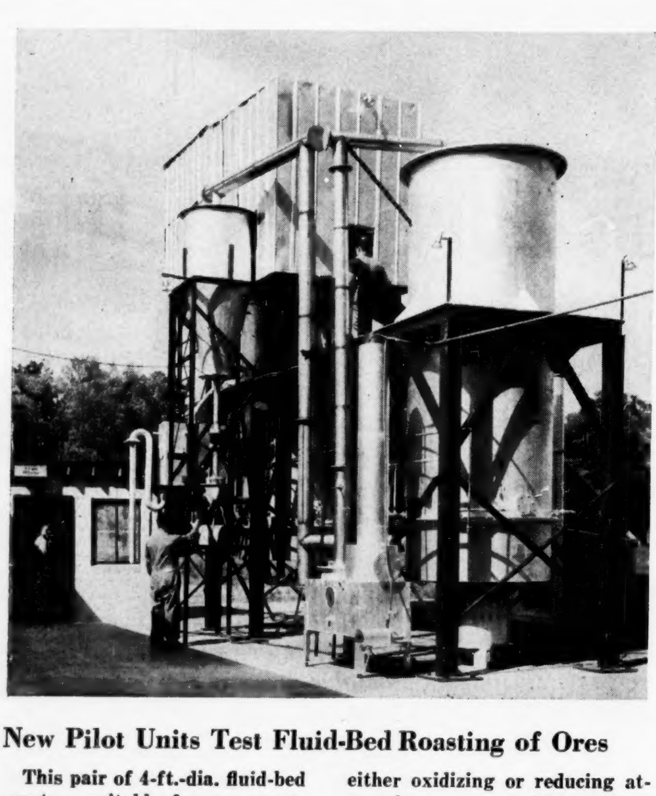
• Uses ore fines and powdered ore directly. (These must be pelletized or sintered for use as blast-furnace feed.)

• Requires lower capital commitments. (A decision to build a blast furnace, plus its accompanying coke ovens and auxiliaries, may involve an outlay of $30-60 million at a single stroke. Several smaller fluid-bed units, built over a period of time, would take smaller bites of capital.)

• May cut operating costs. (High-priced steel scrap isn't required, and costly maintenance shutdowns of big segments of capacity are eliminated.)

▶ **Out-of-Town Tryout**—But potential cost savings largely depend on the price of natural gas and the freight on the ore.

This means that the technique is likely to be used first in a country where natural gas is plentiful and ore is close at hand. Venezuela, which now lacks a steel industry, is the prime prospect. Iran, India and our natural-gas-rich Southwest are other likely sites for fluid-bed reduction plants.



New Pilot Units Test Fluid-Bed Roasting of Ores

This pair of 4-ft.-dia. fluid-bed reactors suitable for ore roasting on a tonnage basis has been installed at the pilot-plant laboratory of Battelle Institute, Columbus, Ohio. They can roast ores in one or two stages in either oxidizing or reducing atmospheres, accept either solid or slurry feed, are equipped with instruments for measuring and controlling temperature, pressure, gas flow and composition.

Humidity Conditioner Doubles as Air Sterilizer

Kathabar, a familiar mechanical system for atmospheric humidity control, may be headed for a new job—removal of airborne microorganisms. This will not come as a complete surprise to some Kathabar users who have noticed that the unit reduces bacteria, mold and pollen counts in dehumidified air.

Armed with documentation from Toledo University, Kathabar's manufacturer, Surface Combustion Corp., Toledo, Ohio, is recommending the units on this new basis. Tests at the university show that more than 97% of the airborne microorganisms are removed from air passing through the Kathabar unit. Bacteria count in hotel air was sliced from 52.5 colonies/cu. ft. to 0.97 colonies/cu. ft.

Apparently microorganisms are captured and destroyed by Kathabar's chemical moisture absorbent, an aqueous solution of lithium chloride, which also acts as a bactericide.

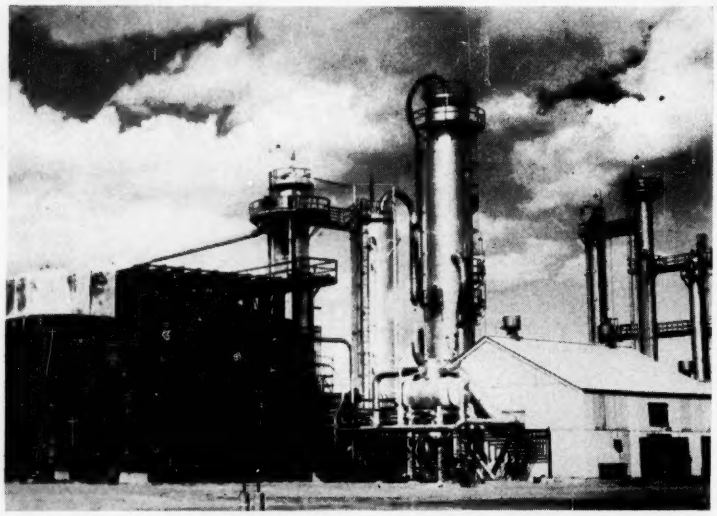
Titanium: Expansions All Along the Line

Stauffer Chemical Co. will complete a major plant to produce titanium tetrachloride at Ashtabula, Ohio, late in 1957. It will supply $TiCl_4$ to a 10-million-lb./yr. titanium sponge plant to be completed at the same time in the same area by National Distillers.

Like Electromet's plant recently put on stream in Ashtabula (*Chem. Eng.*, July 1956, p. 130), National Distillers' plant will use metallic sodium to reduce titanium tetrachloride to titanium sponge. National Distillers will supply both plants with sodium.

To cast and forge titanium ingots from sponge, Oregon Metallurgical Corp. has recently completed a $750,000 plant at Albany, Ore.

And American Cyanamid is adding facilities to its Savannah, Ga., plant to expand production to 72,000 tons/yr. of titanium dioxide pigment.



NEW TRAYS boosted throughput of crude distillation towers by about 60%.

Enter the Ripple Tray

With 27 installations operating or under construction, the ripple tray deserves consideration by chemical engineers with problems in distillation or absorption.

Towers shown here contain something new in two-phase fluid contacting—the "ripple" tray. Developed by Stone & Webster Engineering Corp., Boston, and now being used in a variety of services in petroleum refineries and chemical plants, the ripple tray is the latest competitor of the traditional bubble-cap and sieve (perforated) tray for chemical engineers' attention.

Able to be used with higher liquid loadings than bubble-cap trays and incorporating greater flexibility than sieve trays, ripple trays will base their bid for the chemical engineer's favor on these strengths. For example, the towers above make up a crude-oil distillation unit that formerly processed 20,000 bpd. with bubble-cap trays. Switched over to ripple trays early last summer, the unit now processes 31,500 bpd.

In this installation, fractionation suffered at greater-than-design liquid loadings when bubble caps were used. With ripple trays at these high loadings fractionation is reported to be comparable to the best obtained with bubble caps operating at their lower design loadings.

► **Catching On Fast**—First commercial tower to use ripple trays started up in September 1954. It is used for washing raw ether with caustic soda. Now, about 27 ripple-tray installations are either operating or under construction.

Other installations of ripple trays include a paper plant, which uses them in a column to make sulfite liquor by absorbing sulfur dioxide in sodium carbonate solution, and a chemical company, which has them in a tower fractionating a methanol-formaldehyde mixture.

► **How It's Made**—Invented by S&W's Margaret Hutchinson and the subject of U. S. Patent 2,767,967, the ripple tray is simply a perforated tray with sinusoidal waves pressed into the perforated sheet metal. These impressed waves add a design variable that extends the operating range of the usual perforated tray.

Both wave spacing and amplitude can be designed to handle specific vapor or liquid loadings. Waves are shallowest for low liquid loadings, deepest for high liquid loadings. In current towers, ripple "period" varies from 1½ to 2½ in., "amplitude" ranges from ½ to 1½ in.

Usually, ripple trays are made in sections framed by vertical rims. Each section is narrow enough to pass through an 18-in. manhole. Sections are bolted together inside the shell, and the complete tray is clamped to a narrow support ring. Up to a tower diameter of 9 ft., no beams are needed. With supporting beams, ripple trays can be made to accommodate any tower diameter.

In small-diameter towers, one-piece trays that require no support rings are sometimes used, especially in copper towers where a slip-fit against the shell is easily obtained.

Total open area is usually 15-30% of tower cross-section. For clean service ⅛-in-dia. holes are used. Larger holes are used for fouling conditions.

► **Down With Downcomers**—Troughs of waves act as preferential discharge points for downflowing liquid. This eliminates the need for downcomers and forces good distribution of liquid onto the froth of the tray below. Good liquid distribution is further assured by orienting the waves in adjoining trays at 90° with respect to each other.

Absence of downcomers accounts in part for the higher capacities of ripple trays. More than 90% of the tower cross-section is active contacting area. In conventional towers, tray area occupied by downcomers lowers this percentage considerably.

► **What It Does**—The ripple tray supports a bed of froth much as any flat sieve tray does but, according to S&W, there is more pronounced turbulence, hence more efficient contacting, with the ripple tray.

Trays function almost as well with the froth only an inch or two deep as with it nearly filling the space between trays. At design conditions, froth height is

usually about half the tray spacing.

This makes for great flexibility. From roughly 70% to 140% of design loading, ripple trays maintain their separating efficiency.

▶ **Trays Stay Clean**—High turbulence also helps keep ripple trays clean. There are no stagnant areas above the tray, and the continuous washing action of the liquid running off the underside keeps that clean, too.

In one of the towers in the refinery installation mentioned above, ripple trays with $\frac{1}{4}$-in. holes were substituted for bubble-cap trays for distilling a tarry visbreaker heater effluent. Though bubble caps had coked almost solid after a few weeks, ripple trays have stayed entirely clean during extended operation.

▶ **Low Pressure Drop**—Pressure drop is lower with ripple trays than it is with bubble caps. Conversely, for the same pressure drop, ripple-tray columns can handle much higher liquid and vapor loads. S&W says that in vacuum service, where pressure drop counts, it can be held below 1.5 in. of water per tray over a wide range of column loading.

S&W data indicate that when the two types of trays operate with the same pressure drop and about the same liquid holdup, required cross-sectional area of the ripple-tray tower is only about half that of the bubble-cap column.

▶ **Uses Alloy Steel**—Typically, S&W uses 16- or 18-gage plate of Type 410 stainless to make the trays. This provides positive protection against corrosion or erosion that would result in hole enlargement and deterioration.

Since relatively little material is used, the cost of using stainless steel is not significantly higher than that for mild steel.

Mideast Crisis Spurs Oil-Sands Work

Look for work on oil recovery from Alberta's oil sands to be stepped up as a result of the current series of crises in the Middle East. Oil industry sources disclosed that "various confidential conferences" are now under way on the problem.

New leases taken out by oil firms in recent months are said to have virtually blanketed the oil-sand area. Two of the companies taking a leading role in this activity, Royalite and Can-Amera, are expected to release a joint progress report shortly describing the area's development.

Can-Amera has worked out a centrifugal separation process to recover crude oil from the sands (*Chem. Eng.*, June 1955, p. 130) and is expected to join with Royalite in building a plant soon. An Alberta government spokesman says a costly sulfur-extraction step is one bar to immediate commercialization.

And oil sands in Vernal, Utah —over 100 ft. thick—are coming in for a share of attention, too. Standard Oil (Ohio) has taken a lease on them and has begun exploration.

Exploitation of shale, another hard-to-tap source of oil, has come a step closer with the news that Union Oil is about to start shakedown testing of its demonstration plant to handle 300 tons/day input. According to a statement made by Interior Secretary Seaton at a recent API meeting, both industry and government are giving increased consideration to the long-range possibility of getting oil from shale.

News Briefs

Nylon: Capacity of Chemstrand's Pensacola, Fla., nylon plant will be hiked from 58 million to 114 million lb./yr. To meet demand for nylon yarn in tire cord and industrial uses, Chemstrand rise has same objective as new 40-million-lb./yr. plant planned for Richmond, Va., by Du Pont.

Uranium: Utah Construction Co. plans to build a $10-million uranium mill in Fremont County, Wyo.

Phthalonitrile: Barrett Div. of Allied Chemical & Dye plans large-scale commercial production of phthalonitrile at its plant in Edgewater, N. J.

Boric acid: Stauffer Chemical Co. plans to increase capacity of its San Francisco boric acid plant via a $500,000 expansion.

Synthetic rubber: American Synthetic Rubber has completed a $3-million expansion adding 50% to its Louisville, Ky., plant capacity.

Volume 64—Chemical Engineering—Number 1

Chemical Engineering, with which is incorporated *Chemical & Metallurgical Engineering*, is the successor to *Metallurgical & Chemical Engineering*, which in turn was a consolidation of *Electrochemical & Metallurgical Industry* and *Iron & Steel Magazine*.

The magazine was originally founded as *Electrochemical Industry*, in September 1902, and was published monthly under the editorial direction of Dr. E. F. Roeber. It continued under that title until January 1905 when it was changed to *Electrochemical & Metallurgical Industry*. In July 1906 the consolidation was made with *Iron & Steel Magazine* which had been founded eight years previously by Dr. Albert Sauveur. In January 1910 the title was changed to *Metallurgical & Chemical Engineering*, and semi-monthly publication was begun Sept. 1, 1915. On July 1, 1918, the title was changed to *Chemical & Metallurgical Engineering* and weekly publication was begun Oct. 1, 1919. Monthly publication was resumed in March 1925.

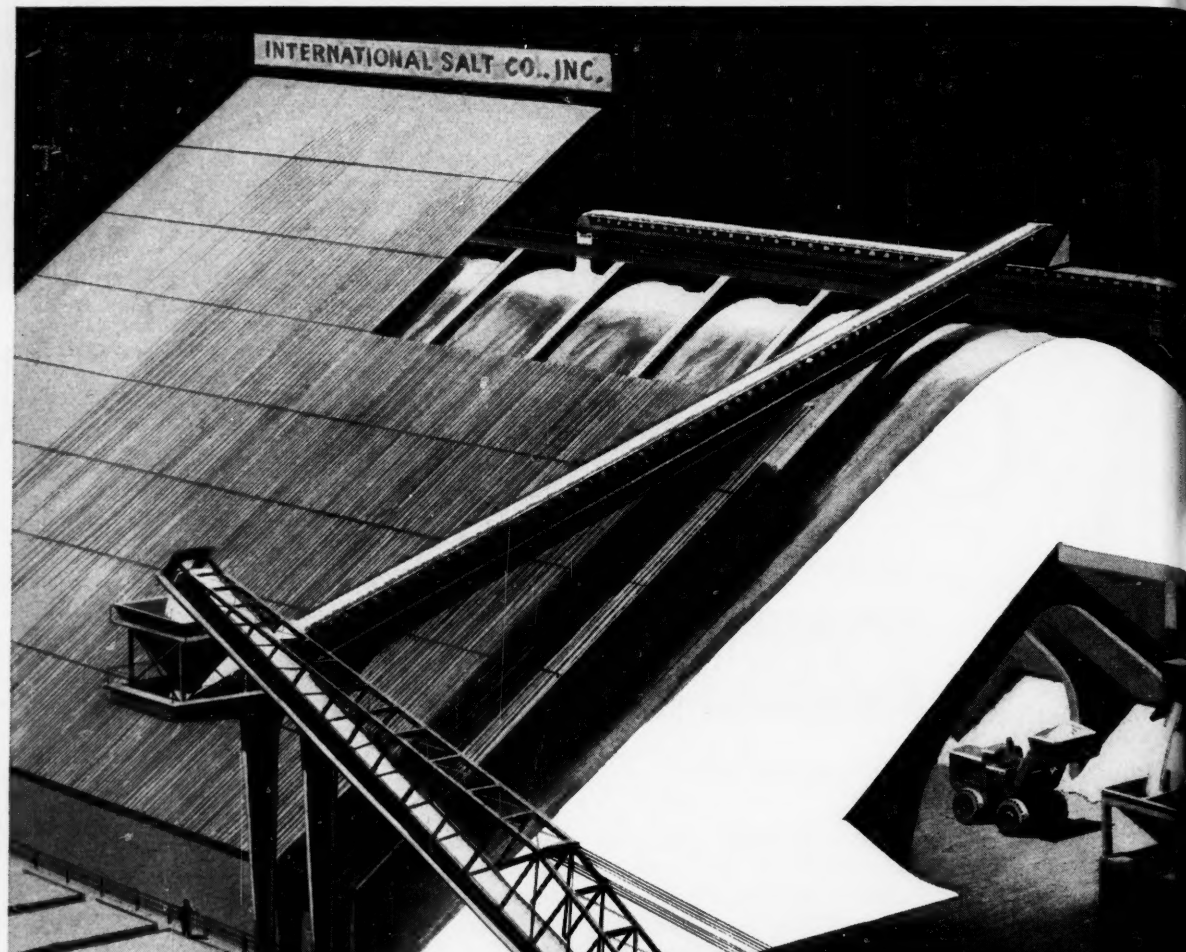
In August 1946 the words *"& Metallurgical"* were dropped from the main title to bring its name more in keeping with the editorial content.

Dr. E. F. Roeber was editor of the paper from the time it was founded until his death Oct. 17, 1917. After a brief interim he was succeeded by H. C. Parmelee. Ten years later, Nov. 1, 1928, Dr. Parmelee assumed other responsibilities in the McGraw-Hill Publishing Company and Sidney D. Kirkpatrick was appointed editor.

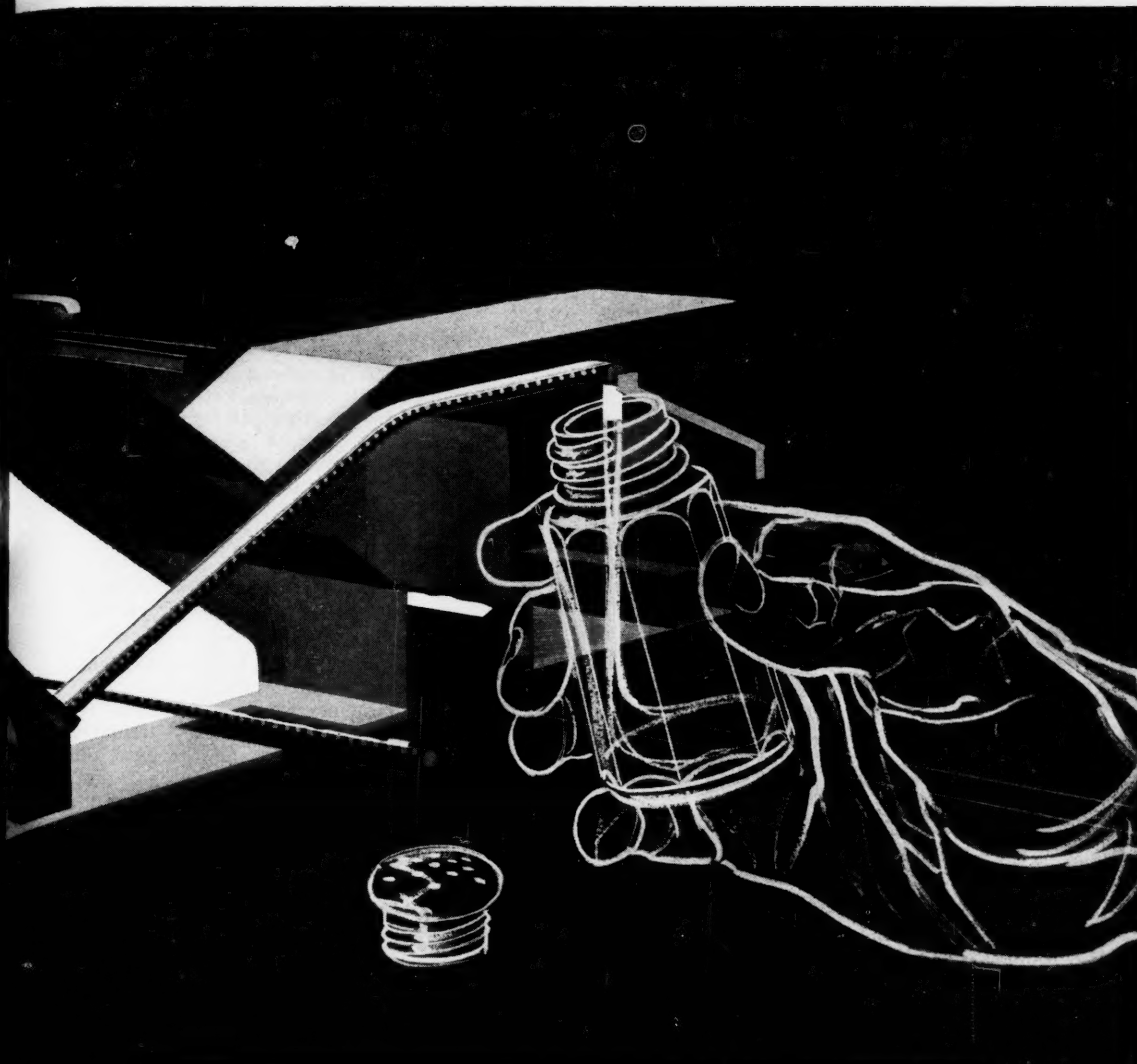
Dr. Kirkpatrick was named editorial director July 1, 1949, and at that time he was succeeded as editor in chief by John R. Callaham.

The present editorial staff is, in addition to Dr. Kirkpatrick and Mr. Callaham: Cecil H. Chilton, editor (developments); Theodore R. Olive, editor (practice); Lester B. Pope, editor (presentation & production); C. S. Cronan, R. F. Fremed, R. B. Norden, associate editors; F. Arne, D. R. Cannon, S. Danatos, T. P. Forbath, M. A. Gibbons, R. K. Gitlin, M. Redfield and H. T. Sharp, assistant editors.

Editorial regional representatives are: J. A. Lee, Houston; Elliot Schrier, San Francisco; F. C. Byrnes, Chicago.

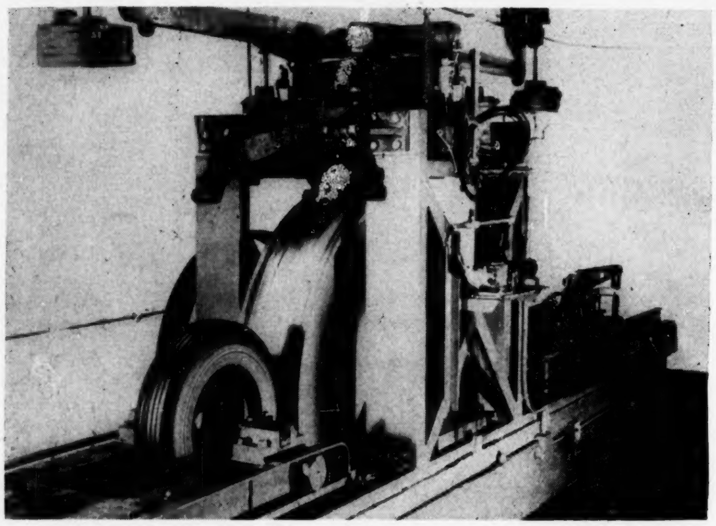


CONVEYOR BELTING AND MACHINERY • INDUSTRIAL HOSE • VIBRATING EQUIPMENT • DESIGN, MANUFACTUR



DEVELOPMENTS . . .

CHEMICAL PRODUCTS EDITED BY R. K. GITLIN



ADDITIVE-SHIELDING now passes butyl in heat-buildup tests.

Chemical Quenches Heat in Butyl Tires

High heat buildup, long a major barrier to butyl's use in tires, has been cooled to workable limits by new modifier.

High heat buildup, one of the big problems that had to be solved before Enjay Co. could produce its all-synthetic butyl tire announced last fall, was checked by a chemical modifier, developed and just made public by Monsanto. Called Elastopar, and now in semicommercial production, the product is N-methyl-N, 4 dinitroso aniline.

Not only does Elastopar improve heat-resistant properties of the finished butyl, it does so in the course of conventional processing steps. Before its development, a way did exist to bring butyl's heat buildup down to a range competitive with that of GR-S used in passenger-car tires, but only at the expense of unusually high processing temperatures and long mixing cycles.

Both Monsanto and Enjay (Esso subsidiary which bought the government's butyl plants in 1955) expect the development to expand the general-purpose position of butyl rubber, prompting its adoption in a wide variety of mechanical goods including hose, electrical insulation and air springs.

Factory-confirmed tests show it doubles resilience and strength and significantly increases the electrical resistivity of unmodified butyl. Specific physical properties of recommended formulation, 1.2 parts Elastopar to 100 parts butyl, compare with unmodified butyl as follows:

	Unmodified	Modified
300% Modulus, psi.	1,400	1,930
% Elongation	560	450
Shore hardness	67	60
Torsional hysteresis @ 77 F.	0.404	0.174

Potential market in air springs is an especially interesting comer. Word is that within two years most passenger cars will come equipped with rubber air springs. And shock absorbency is a natural strong point of butyl, taking credit for superior tire performance on counts of softer, quieter rides; better road-gripping action; freedom from squeal. But shock energy must go somewhere which, in turn, accounts for butyl's weakpoint—high heat buildup—now controlled by Elastopar.

Enjay is already testing butyl tires on employees' cars and, within two or three months, will begin test-marketing through the Esso parent company's filling stations under the Atlas tire label.—**Monsanto Chemical Co., St. Louis 4, Mo.** 142A

Coating Protective

Vinyl-based, it eliminates odor and need for surface preparation.

Like other vinyl-based coatings, easy-to-apply Ucilon 1400 provides excellent corrosion resistance, but also eliminates strong odors and the need for meticulous surface preparation.

The new vinyl maintenance coating resists acid, alkalis, water and other causes of early paint failure. Its mild odor and high flash point permit application without interference with plant routines.

Ucilon 1400 is self-priming and brushes out like oil paint, with no sagging or dripping. Potential applications: walls, floors, ceilings, equipment exteriors which might be exposed to corrosive fumes and other industrial atmospheres.—**Metal & Thermit Corp., Dept. 1400, Rahway, N. J.** 142B

Glass Dispersions

Protect metals like steel and titanium during hot working.

Developed by Acheson Colloids Ltd. to protect titanium alloys from oxidation and hydrogen embrittlement, coatings consisting of finely divided glass dispersed in chemical and resin solvents (e.g., silicones, mineral oils, ethyl and isopropyl alcohols) are already in successful use in the manufacture of Nimonic, as well as titanium, turbine compressor blades.

Newsworthy chemicals this month

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Called dag 1205B, one of these dispersions—a semicolloidal glass in isopropanol—gives protection to a number of titanium alloys while they are being worked. After vapor degreasing of the metal, the coating is applied by dip, brush or spray.

In this particular case, the glass itself may not be sufficient as a lubricant because it freezes and tends to stick in the dies. Dry graphite coating applied to the disk solves the problem. But, in most cases, the glass in the dispersions acts as a satisfactory lubricant.

Coatings can be dried in air or baked dry. A wide variety of resins and glass particle sizes can be used in the preparation of these protective glass dispersions.—**Acheson Colloids Ltd., 18 Pall Mall, London S.W. 1, England.** 142C

Textile Fire Retardant

For permanent protection of cellulose fibers.

Cellulose fibers can now be made permanently flameproof by combination, without catalysts or special conditions, with phosphorylamide. Recently made available for industry-wide use by Wica Chemicals, this new treatment is applied in cold padding operations and simply dried and cured at 290 F.

Phosphorylamide possesses almost unlimited compatibility with other finishes and auxiliary chemicals, e.g., water repellents, lubricants, softeners, builders, thermosetting and thermoplastic resins.

Solutions as dilute as 4% have been shown to suffice. Concentrations up to 20% have been used without drastically affecting the hand of the impregnated fabric after rinsing in cold water.

Phosphorylamide is marketed as a 50% solution. Drapes and other decorative fabrics with appreciable cellulose content are targeted for immediate interest. The chemical is also being considered for flameproofing cellulosic paper and paperboard products.—**Wica Chemicals, Inc., Charlotte, N. C.** 144A

Water-Emulsion Vehicle

Disperses chemically reacted drying oils in water.

Arolon 110, Archer-Daniels-Midland's water-emulsion paint vehicle made from vegetable oils, successfully disperses chemically reacted drying oils in water.

Advantages of paints made with the new vehicle include:

- Ease of application—with a brush or roller.
- Higher resistance to water, when dry, than other water-emulsion paints.
- Quick drying.
- Little or no odor.
- Good adhesion to glossy surfaces.

Arolon 110 can be made in flat or semigloss finishes, resists freezing and thawing, won't settle during storage.

ADM, which makes no paints itself, says that paints containing its new product won't be available at retail stores for at least six months to a year. It normally takes that long for such products to be adapted by manufacturers and get into retailers' hands.—**Archer-Daniels-Midland, 700 Investors Bldg., Minneapolis 2, Miss.** 144B

Diesel Lubricant

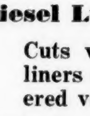
Cuts wear in pistons and liners of residual-fuel-powered vessels.

The trend toward use of residual fuels can cut fuel bills by about one-third. Their use, however, results in increased cylinder liner wear and has created the need for improved, wear-reducing lubricants.

One such lubricant is Tro-Mar DX-130 which reduces wear up to 90% in pistons and liners of large, slow-speed (100-300 rpm.) diesel engines powering tankers, cargo and passenger ships using residual fuels.

Savings realized through use of the new lube will depend on local conditions. Maintenance costs, even with residual fuels, are reduced to a level approxi-

For More Information...



about any item in this department, circle its code number on the Reader Service Postcard inside the back cover.

mating that usually found with distillate fuels. The average cylinder liner wear reduction of 65% and piston assembly wear reduction of 50% cut by at least one-half the costly time now lost in engine maintenance. And important savings are also made in cost of replacing parts.

Tro-Mar DX-130 is quite different from conventional cylinder oils in that it has a grease-like structure and is opalescent (not semitransparent). It is now available in most world ports.—**Esso Research and Engineering Co., 15 W. 51st St., New York 19, N. Y.** **144C**

New Chemical Intermediates

Organofunctional silanes undergo classic organic reactions. Their availability opens up new markets as well as new areas of research and development for silicones.

With the introduction of a new class of monomeric, silicon-containing chemical intermediates—organofunctional silanes—Union Carbide claims to have taken the first step toward opening the door to a new chemical field, one which links organic and silicone chemistry.

What's unique about the new silanes? In contrast with other, inert silicones, they can be reacted with organic chemicals as organic chemicals to yield a host of industrially important products. Key to this organic reactivity is the addition of functional groups to conventional organosilanes. As a result of these reactions, properties like solubility, compatibility, volatility and thermal stability in materials being worked with can be modified.

▶**Four Available**—At present, Carbide is offering four organofunctional silanes for industrial evaluation—γ-aminopropyltriethoxysilane, δ-aminobutylmethyldiethoxysilane, β-carbethoxyethyltriethoxysilane, β carbethoxyethylmethyldiethoxysilane.

Both amino-modified ethoxysilanes undergo classic amine reactions, e.g., with inorganic acids to form acid salts; with organic acids to form amides; with esters to form amides; with aldehydes and ketones to form substituted azomethines; with alkyl halides to form quaternary ammonium compounds; with isocyanates to form disubstituted ureas. They also undergo such silane reactions as hydrolysis, transesterification and cohydrolysis.

Similarly, carbethoxy-modified ethoxysilanes undergo reactions typical of both aliphatic and silane esters—e.g., saponification with water and alkali, transesterification with excess water, cohydrolysis, reactions with amines.

▶**Markets in the Making**—Carbide doesn't plan to go into the finished-product race with its new compounds. It prefers, instead, to let customers and prospects follow up their own ideas in developing applications for the new silicon intermediates. But company chemists have been doing exploratory work to determine general fields of interest for others to investigate more fully.

Among those areas already showing promise are:

- Finishing Agents—Glass cloth finished with γ-aminopropyltriethoxysilane gives superior glass cloth laminates with melamine, phenolic and epoxy resin systems. β-carbethoxyethyltriethoxsilane offers interesting possibilities as a dispersant coating for clay, mica and other fillers.
- Pharmaceutical Agents—Preparation of sulfonamides by reaction with sulfonyl chloride derivatives, pyrrole compounds prepared by treatment with γ-diketones or amine salts obtained from compounds like penicillin are a few of the reactions which might be used in developing new pharmaceutical products.
- Pesticides—Amino group of both amino-modified ethoxysilanes provides a link for preparation of compounds with pesticidal activity. Among the derivatives which have been prepared and which have application in this field are salts of dithiocarbamic acids, salts or amides prepared from acids of established biological activity such as pentachlorophenol and 2,4-dichlorophenoxyacetic acid.
- Cosmetics—β-carbethoxyethyltriethoxysilane and its hydrolysis product are intermediates for incorporation of silicones into cosmetic and toilet preparations like perfumes, antiperspirants, cosmetic creams and dentifrices.
- Synthetic Resins—Amino- and carbethoxy-modified ethoxysilanes have already been incorporated into polyamide, polyurethane and epoxy resin systems.—**Silicones Div., Union Carbide & Carbon Corp., 30 E. 42nd St., New York 17, N. Y.**

146A

Silicones: Rubber, Resin

Rubber is electrically conductive, resin reduces concrete spallage.

In addition to its organofunctional silanes, Union Carbide has two other silicones on the market—one, a rubber; the other, a resin.

- X-1516 silicone rubber, a flexible, thermosetting material with a high degree of electrical conductivity, can be molded, calendered or extruded without appreciably changing its electrical properties. This, in contrast to organic rubbers which must be carefully handled to preserve their electrical conductivity.

The new silicone rubber shows superior performance to extrusion die contours and mold surfaces so that it can be made into difficult or odd shapes. It could, for example, be used to make an electric heater which wouldn't break as easily as a ceramic or graphite heater.

Because of its conductivity

and resistance to high temperatures, X-1516 can be used to make antifogging heater pads on aircraft cameras. Other applications: electrically conductive shields for silicone-insulated electrical equipment; industrial rolls; electrically conductive tubing or hose to drain static charges, prevent sparking or handle explosive gases or dusts.

Like other silicone rubbers, X-1516 is thermally stable; inert; nonsticking; resists weathering, corona and ozone. Electrical resistivities of less than 100 ohm-cm. are easily obtained with the new compound.

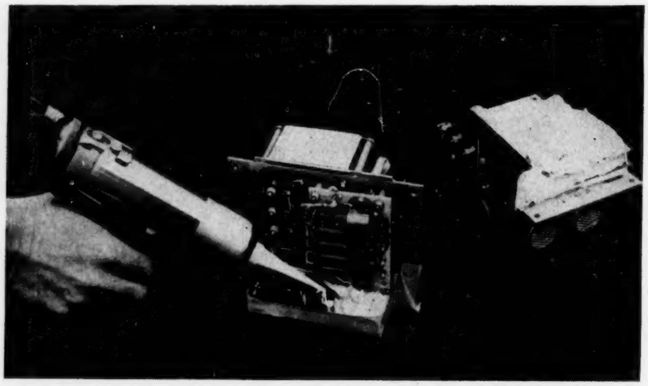
• Spallbar is a silicone resin aimed at reducing a common highway maintenance problem —concrete spallage.

Two major causes of spalling are the alternate freezing and thawing of absorbed water and chemical attack of calcium salts used in winter ice removal. Spallbar checks these damaging effects by reducing the amount of water that concrete can absorb and reducing penetration of calcium salts.

Since spalling is especially serious on bridges and concrete roads where there's considerable traffic acceleration and deceleration (e.g., near intersections, on grades and curves), the new silicone repellent should be particularly effective on these areas.

Spallbar may be used on highways as soon as the concrete has set sufficiently to support the weight of spraying equipment—usually about seven days after concrete has been poured. It can be applied at temperatures above 15 F. (lower temperatures reduce rate of solvent evaporation), but shouldn't be used where concrete is water-saturated or where ice has formed.

Unlike many other highway water repellents now on the market, Spallbar isn't water soluble, thus can resist loss in repellency from rain. Other advantages include: superior resistance to freeze-thaw tests, greater resistance to alkalis, minimum toxicity and combustion hazards (due to low volatility and high flash point of solvent used).—**Silicones Div., Union Carbide & Carbon Corp., 30 E. 42nd St., New York 17, N. Y.** **146B**



Silicone Rubber Protects Guided Missile Components

Application of a new room-temperature-curing silicone rubber to electrical components *(shown above)* is said to provide quick, easy and almost foolproof guarantee of top performance for vital high-impedance circuits in the Snark guided missile, F-89 interceptor and other Northrop Aircraft projects.

According to Northrop designers, a single coating of the rubber, Silastic RTV, cushions vibration at low temperature, provides maximum moisture resistance, improved electrical properties of the panel (especially surface resistivity), protects assemblies from rough handling.

Once electronic panels in the circuits have been packed with resistors, capacitors, transistors and other gear designed to record or transmit information during flight, panels are coated with Silastic RTV—using a Semco gun at 100 psi.

After assembly, inspection of individual components is easy: Silicone rubber is simply split open, exposing the unit for removal. When the component is replaced, the slit is patched with additional RTV.—Dow Corning Corp., Midland, Mich. 148A

Wear-Resistant Lubes

Prevent leakage, preserve packings, lower operating and maintenance costs.

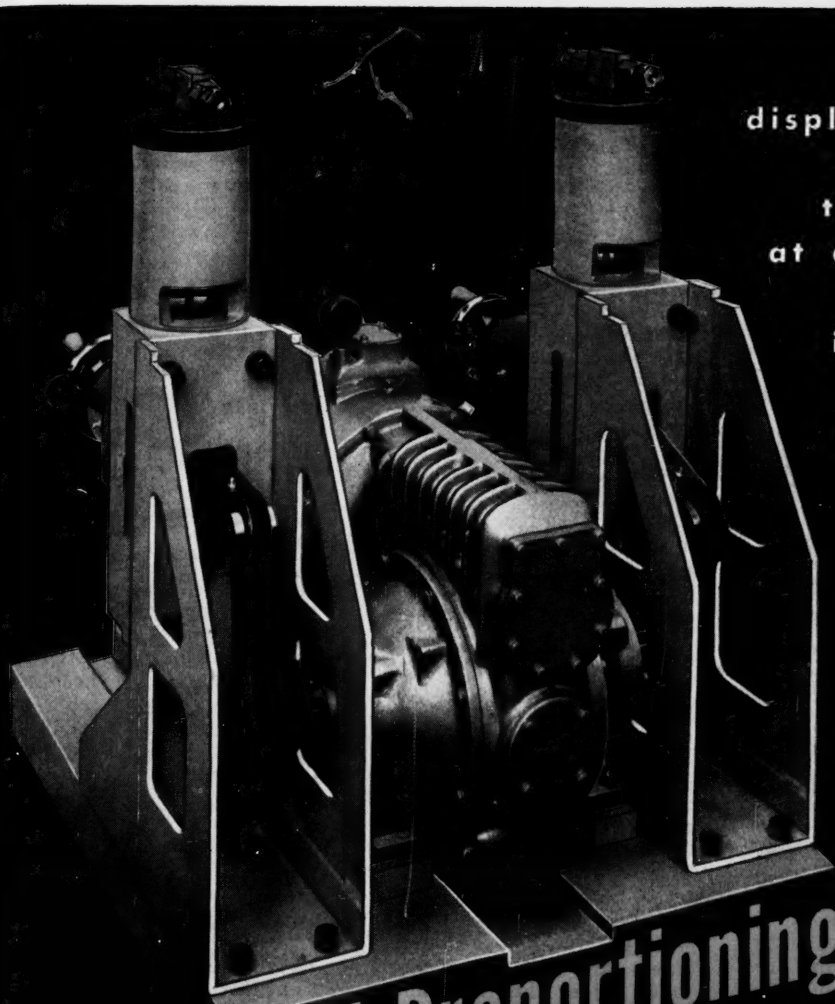
Keystone's 5P line of acid- and alkali-resistant greases affords protection against more than 100 corrosive agents and solvents used in such industries as food processing, chemical, rubber, plastics, paper, textiles, etc.

The new line consists of three different types—5P7, 5P8, 5P9 —having the following physical properties.

- Operating range—0 to 360 F.
- Body—smooth and nonfibrous.
- Color — pale amber to light cream.
- Consistency — heavy, medium, light or X-light.
- ASTM penetration — 200 to 300.

All are said to provide superior lubrication to plain and antifriction bearings, pump packing glands and lubricated plug valves.

Because they resist corrosion, prevent loss of expensive materials and outlast conventional lubricants, these specialized greases lengthen equipment life



and cut both manufacturing and maintenance costs.—**Keystone Lubricating Co., 3100 N. 21st St., Philadelphia 32, Pa.** 148B

Latex Binder

Withstands temperature extremes, forms durable film.

A new latex binder which may be formulated with latex paints for a broad range of exterior and interior uses is reported to have exceptionally good weatherability and excellent film-forming characteristics.

Described as an interpolymer latex made from a combination of monomers, the new latex, Lytron 680, has already been field-tested in 14 locations characterized by radically different climes (from 38 F. to 107 F.). And here's what makes it look so good:

- Dries quickly, forming a tough, flexible film which strongly resists oxidation.
- Binds an unusually high volume of pigment—even at near-freezing temperatures—into a tight, water-resistant film in a relatively short period.
- Exhibits good adhesion to a variety of exterior and interior surfaces like concrete, stucco, masonry, cinder block, cement-asbestos shingles, previously painted wood.
- Resists chalking and blistering.
- Resists mildew.
- Is nontoxic and nonirritating to the skin.

Lytron 680, now commercially available, is being manufactured at Monsanto plants in Springfield, Mass., and Santa Clara, Calif.—**Monsanto Chemical Co., Dept. TC, Springfield, Mass.** 150A

BRIEFS

Phosphorus pentasulfide in two grades—regular and reactive—is now available from Monsanto in carload or truckload quantities. With reactive grade (unlike regular grade), reaction starts so quickly that no external heat is needed and normal plant cooling systems often must be increased to provide adequate control. Result: Reactions are completed in less time, permitting more total production in equipment. Principal uses of P_2S_5 are in lube additives, thiophosphate insecticides, rubber additives, catalyst in blowing asphalt, stabilization of aromatic amines, intermediate in organic synthesis. —**Inorganic Div., Monsanto Chemical Co., St. Louis 1, Mo.** 150B

Epoxy-based protective coating, Poxycote, protects metal, wood or masonry surfaces against corrosive fumes, moisture and drippage of almost all chemicals. Its insoluble, inconvertible and nonporous film has superior resistance to impact and abrasion, retains excellent adhesion even during extreme temperature changes. Depending on surface to be coated, one gallon will cover 300-1,000 sq. ft. at a cost of 2¢-5¢/sq. ft.—**National Coating Products, Inc., 307 W. 16th St., New York 11, N. Y.** 150C

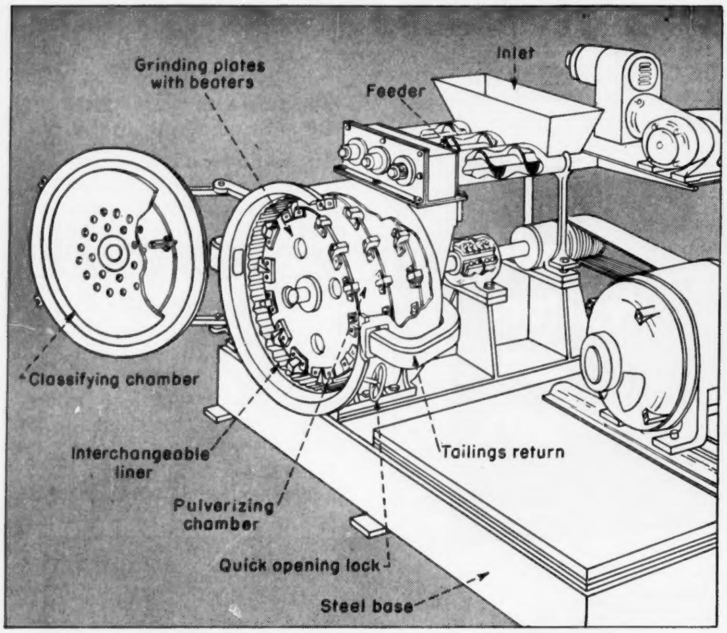
Cyclic tertiary amines of high molecular weight (imidazolines) are now being marketed under the tradename, Nalcamine. These compounds have an extremely wide range of uses including emulsifiers, demulsifiers, dispersants, wetting agents, plasticizers, corrosion inhibitors, solvent penetrants. And manufacturer claims that high purity, uniformity and lower manufacturing costs of its products will further increase commercial use of the amines. —**National Aluminate Corp., 6236 W. 66th Pl., Chicago 38, Ill.** 150D

Release agent, Sonite Seal-Release, can be rubbed to an imperceptible film after application, making for easy parting of epoxy resin castings from plaster molds; metal, wood or epoxy masters. In addition, the new agent seals surface pores to exclude water vapors. Seal-Release can be applied by rubbing, brushing or spraying. For deep penetration and spraying, it can be cut with naptha, gasoline or kerosene. — **Smooth-On Mfg. Co., 572 Communipaw Ave., Jersey City 4, N. J.** 150E

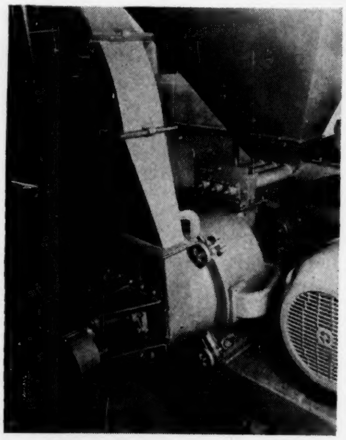
Diethylbenzene, in an Engraver Grade, is an improved grade of diethylbenzene which overcomes objections to the product's odor in the etching bath. The new grade, used in conjunction with nitric acid in etching of magnesium in photoengraving (Dow process), has passed tests established by the American Newspaper Publishers Assn. Research Institute.—**Koppers Co., Pittsburgh 19, Pa.** 150F

Fast-curing silicone resin, SR-120, can be baked in 30 minutes at 400 F. to produce finishes which are superior to organic coatings in heat resistance and comparable to them in hardness, flexibility, impact, chemical resistance. Because it allows faster baking at lower temperatures, the new copolymer is expected to permit manufacturers using silicone finishes to speed up production lines on equipment which require heat-resistant coatings. SR-120 films can withstand continued exposure up to 440 F. and may be pigmented.—**Silicone Products Dept., General Electric Co., Waterford, N. Y.** 150G

Three new laminating adhesives are Resyn 36-6324, Resyn 76-3930 and Resyn 76-3944. 36-6324, a rubber-based, transparent adhesive with viscosity of 2,500 cp., is used in laminating cellulose acetate butyrate to foil in metallic yarn production. 76-3930, a clear liquid, vinyl lacquer with viscosity of 500 cp., laminates printed cellulose acetate to foil to make "boilable" flexible containers. For laminating Mylar to metallized Mylar or Mylar to foil, Resyn 76-3944 is used. It's a rubber-based translucent adhesive with a viscosity range of 2,000-3,000 cp.—**National Adhesives Div., National Starch Products Inc., 270 Madison Ave., New York 16, N. Y.** 150H



AIR sweeps fines out of grinder into classifier. Oversize recycles to grinder.



TWENTY-inch mill grinds 800 lb./hr. of sugar to —325 mesh fines.

Grinder Makes Uniform Fines

Combination grinding mill and classifier produces uniformly sized fine particles within narrow range. Differential rotor speeds permit close control.

Particles finer than -325 mesh can be produced with greater economy using the new Pulvocron grinder and classifier, according to the manufacturer. The particles are sized more uniformly with closer distribution of size over a narrow range.

▶ **Separate Control**—The exclusive feature said to be offered by the Pulvocron is separate control of the grinding and classifying chambers. The grinding and classifying rotors can be operated at differential speeds to obtain the highest possible efficiency. Yet both units are encased within a single housing.

The Pulvocron grinds by air attrition and impact. Particles are then classified by an air stream that moves radially inward against centrifugal force. In this fashion close classification cuts are obtained on fine particles.

While the principle of radial inward classification is not particularly new, its application in conjunction with air attrition and impact under controlled conditions is considered novel.

▶ **Feed to Product**—A feeder mechanism pushes material into the main grinding chamber of the Pulvocron. Strong centrifugal force set up by the revolving beaters moves the feed between the first grinding element and the backplate, then to the outer periphery between the beater tips and liner.

As the solids become suitably ground, they are carried radially inward by the air stream to pass through holes in the grinding plates and into the classifying chamber. Here, the primary and secondary classifying plates reject oversize to the outer periphery for recycle through the tailings duct to the grinding chamber. Final product fines are drawn through holes in the center of the classifying plates and into the discharge housing.

▶ **Operating Range**—The Pulvocron will produce particle sizes from a range of 99% less than 5 microns up to as coarse as 50 mesh. This broad range is achieved through separate control over the rate of feed, grinding action and classification at desired cut point.

The initial model of this machine has a 20-in. dia. chamber which will take up to 75 hp. on the grinding side and utilize a 3-hp. classifying motor. Unit also uses a ½-1-hp. feeder motor and up to a 10-hp. exhaust-fan motor.

On granulated sugar, this unit will produce better than 99.9% —325 mesh at a 600-800 lb./hr. rate using 40 hp. By adjusting the classifier, this rate can be increased to 1,300 lb./hr. of 99.7% —325 mesh product with 60 hp. power demand. Or the Pulvocron will produce 400

They Knew What They Wanted

The twelve LaBour Type G pumps in this picture are handling plating solutions and waste, acid and alkaline, in a large Michigan plant producing small hardware for automobiles. In this highly competitive business every penny of cost is scrutinized with a thorough-going care not always found in other industries. The fact that this company chose LaBours is evidence that they expect minimum over-all costs.

As this is written the twelve pumps have been operating on a two-shifts-per-day basis for eight months with no trouble. Since these are LaBour *packingless* pumps, maintenance has been virtually nil.

If you are trying to hold costs down—and who isn't, these days?—it will pay you to investigate LaBour pumps for handling your corrosive and other difficult liquids. We can show you some mighty interesting performance facts and figures.

LaBOUR

Equipment Developments This Month

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lb./hr. of −10 micron dehydrostreptomycin with 40 hp.

Testing to date indicates ready acceptance for the Pulvocron in the sugar and pharmaceutical industries for fine grinding of products such as sucrose, dehydrostreptomycin, stilbestrol, milk sugar and dry milk powders. Now underway are testing programs for the plastics and paint industries.

▶ **Limitations**—The Pulvocron is not particularly adapted to grinding fibrous materials if extremely fine particles are desired. Materials such as wood pulp, sawdust and alpha cellulose possibly could be ground to 80 or 100 mesh.

Another product that cannot be handled is polyethylene which forms balls and agglomerates.

Temperature rise during grinding varies with the type of material and the fineness of the grind. Under normal operating conditions, temperature in the mill casing can be controlled to 150-155 F. Product will then discharge at 120-125 F.—**The Strong-Scott Mfg. Co., 451 Taft St. N. E., Minneapolis 13, Minn. 152A**

Water Distilling Plant

Produces high-purity water from sea water.

A new sea-water distilling plant has completed a month-long test period by running well over capacity of 1,000 gal./hr. of distillate with less than ¼ grain/gal. total solids in the product.

Design features of the new plant overcome the traditional contamination of distillate by entrained sea water. Operation is reported to be completely automatic, scale-free and trouble-free.

Unit can operate on either low- or high-level heat which permits it to tap waste heat at whatever level it may exist. The only moving parts are the pumps. No compression is needed and the unit has a very low noise level.

In addition to producing pure water, the evaporator can decontaminate wastes and recover valuable components from effluent streams discharging from pulp and paper mills, food and chemical plants.

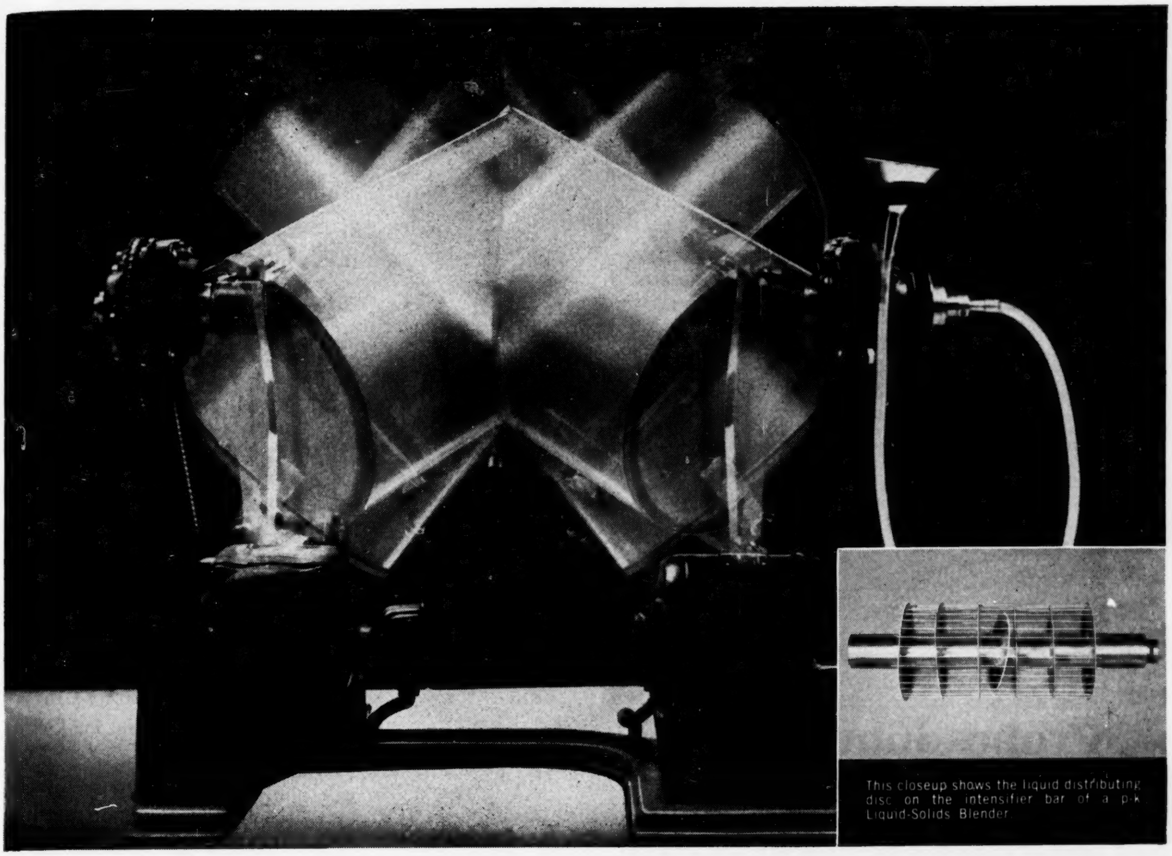
Corrosion-resistant components minimize both corrosion and contamination. Compact units are available in many sizes.

Number of stages in the evaporator will be dictated by the heat source. Small portable units will have two or three stages; larger units will take advantage of the optimum number of stages.—**Badger Mfg. Co., Cambridge, Mass. 154A**

Equipment Cost Indexes

Industry	June 1956	Sept. 1956
Avg. of all	204.2	211.3
Process Industries		
Cement mfg.	194.8	201.6
Chemical	204.3	211.5
Clay products	189.2	195.8
Glass mfg.	193.0	199.8
Paint mfg.	196.6	203.5
Paper mfg.	196.9	203.8
Petroleum ind.	200.7	207.7
Rubber ind.	203.2	210.3
Process ind. avg.	201.4	209.0
Related Industries		
Elec. power equip.	206.2	213.4
Mining, milling	205.6	212.8
Refrigerating	229.0	237.3
Steam power	192.5	199.2

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124-6 for method of obtaining index numbers; March 1956, pp. 194-5 for annual averages since 1913.



This closeup shows the liquid distributing disc on the intensifier bar of a p-k Liquid-Solids Blender.

P-K Liquid-Solids* Blender Creates New Production Concept!

A new, revolutionary method for blending liquids into dry materials is highly successful in practically all chemical and process applications.

Essentially, the p-k Liquid-Solids blender operates in the following manner. Liquids, regardless of viscosity, are introduced into a rapidly revolving bar (by gravity or pump). The liquid is flung outward in a finely divided state from a distributor disc and feeds a continuous fine spray into the tumbling mass of dry materials as the shell rotates. A series of stainless steel wires, strung horizontally along the bar, prevents the formation of agglomerates and further promotes liquid dispersion.

This unique blending operation can be accomplished in *minutes* and eliminates costly, time consuming steps, such as screening, pulverizing and mulling. With the p-k Liquid-Solids blender, you will get a fast, one step operation that guarantees *consistent* blending *uniformity* not otherwise obtainable.

The exclusive p-k dry mechanical seal prevents materials from entering the bearing housing and protects against product contamination. Two vapor and dust-tight quick-opening covers allow easy access to the baffle-free interior for cleaning. The p-k Liquid-Solids blender is available in sizes ranging from 1 to 50 cubic feet working capacity.

*Patented and Patents Pending

Investigate P-K's Blending Concept

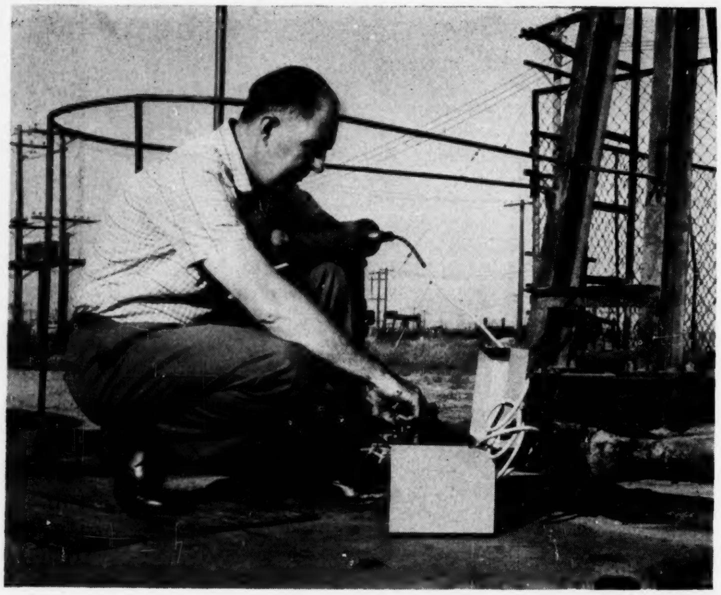
P-K's Customer Service Laboratory will be pleased to test-blend your materials . . . preferably under your supervision. Material formulations will be blended to your exact specifications and returned for analysis, together with a complete report. P-K recommends pre-tests for all "Liquid-Solids" applications, because of the many variables that may affect blending procedures necessary for intimate dispersion of liquids in solids. Our Lab also conducts comparison tests in pilot models of all other basic blender types . . . from ribbon and double cone to p-k's standard Twin Shell and "Intensifier" models.

All of them are members of a growing family of p-k blenders and all are described in our new catalog 14. Write our Mr. R. T. Dotter for your copy . . . and arrange, too, for a pre-test of your materials.

Patterson Kelley
Chemical and Process Division

P-K Twin Shell Blenders* • Heat Exchangers • Packaged Pilot Plants • P-K Lever-Lock Doors*

The Patterson-Kelley Co., Inc., 110 Hanson St., East Stroudsburg, Pa.



Probes Find Corrosion Rate

Speed of corrosion is measured electrically with probes inserted permanently in system. High sensitivity answers rate questions rapidly, within hours or days.

Now, for the first time, you can measure corrosion rates with speed and convenience, without disturbing the system. With the Corrosometer method, you install special metallic probes in the system, then follow how the probes corrode by means of an electric meter.

Individual readings require only 30 sec. No shutdown is needed to retrieve the probes since they remain in the system at all times. Method is the only one that can measure both uninhibited and inhibited corrosion rates on the same metal specimen without removing the metal from its environment.

The most sensitive probes used with the Corrosometer method detect as little as 1/10 of a microinch of corrosion. That means you can establish corrosion rates within hours or days rather than weeks or months.

Probes of more than 30 metals and alloys are available in a number of designs to meet the varying pressure and temperature conditions of different systems.

▶ **Corrosion Changes Resistance**—Operation of the Corrosometer relies on changes in electrical resistance across a piece of metal as its surface corrodes. By using elements with a sufficiently high ratio of length to initial cross section, almost any degree of sensitivity to corrosion rate can be achieved.

Direct measurement of resistance is not practical in the field, as extremely small changes in resistance from low corrosion rates cannot be detected without controlling closely both current through the element and the temperature of the metal.

To make the instrument independent of current, the exposed piece of metal is connected as one arm of a modified Kelvin bridge circuit and the bridge adjusted for a null.

The readings are made insensitive to temperature by using the same metal as the probe in a second, adjacent arm of the bridge circuit. This is located close to the exposed element in the probe. It is protected by a corrosion-resistant coating to retain its original cross-section.

The circuit translates the ratio of resistances of corroding element to non-corroding element directly into microinches or mils of metal lost. After a number of such readings have been taken at intervals, you may obtain the corrosion rate by dividing the difference between two readings by the time interval. Or you may measure the slope of the penetration vs. time curve.

▶ **Averages the Variations**—Within the range of resistance ratio used by the Corrosometer, variations of resistivity at different points along the corroding element tend to average out. Therefore, the penetration figure shown by the meter indicates the total amount of metal lost, averaged over the surface of the exposed element.

Since the probe is constructed of the same material as the metal in the system, the corrosion rate corresponds closely to that of the system in the vicinity of the probe. However, users should remember that corrosion rate within the system may vary greatly from point to point.

Variations in conductivity of the surrounding medium do not affect the readings of the meter because the elements have very low resistance. And the voltage gradient across the exposed metallic conductor is so low that it cannot overcome the opposing effect of overvoltage at the metal-solution surface.

▶ **Components Available**—Three different Corrosometer instruments are now available. The Model C meter for mobile field use is designed for maximum utility and flexibility when used with different shapes and sizes of probe elements. Model K is designed primarily for the laboratory and plant where a.c. power is available. Model R is an automatic, recording instru-

NO STUFFING BOX

POSITIVE DISPLACEMENT

Specify Lapp Auto-pneumatic PULSAFEEDER

. . . for Automatically Controlled Metering of Liquids

The outstanding features of the Lapp "Auto-Pneumatic" Pulsafeeder make possible continuous automatic processing of liquids which cannot be satisfactorily handled by plunger-type metering pumps. The "Auto-Pneumatic" Pulsafeeder is a piston-diaphragm pump providing positive displacement without the problems of a stuffing box. A hydraulically balanced Pulsafeeder diaphragm isolates the product from the working parts of the pump, preventing product leakage or contamination. With pneumatic instrument control, the pumping rate of the "Auto-Pneumatic" Pulsafeeder automatically adjusts from zero to full capacity. Manually adjustable models also available.

WRITE FOR BULLETIN 440 *with typical applications, flow charts, description and specifications of models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Division, 679 Wilson Street, Le Roy, New York.*

Lapp

ment which monitors one or more probes so that a complete statistical study may be made.

Three general types of probes also are available. For testing in open systems such as storage tanks, there is the suspension probe. It consists of sensing elements without a pressure seal.

In the plug probe, the sensing elements are mounted in a metal tube which is supported by a metal housing. The housing contains a pressure seal and cable receptacle. Probes of this type are used in pipe lines, tanks and industrial process equipment.

The retractable probe is used in pressure systems where the probe must be inserted or removed while the system is operating.

Within these three general categories, there are many variations of probe construction to fit a wide variety of service conditions.—**Crest Instrument Co., 11808 South Bloomfield, Santa Fe Springs, Calif.** **156A**

Transmission System

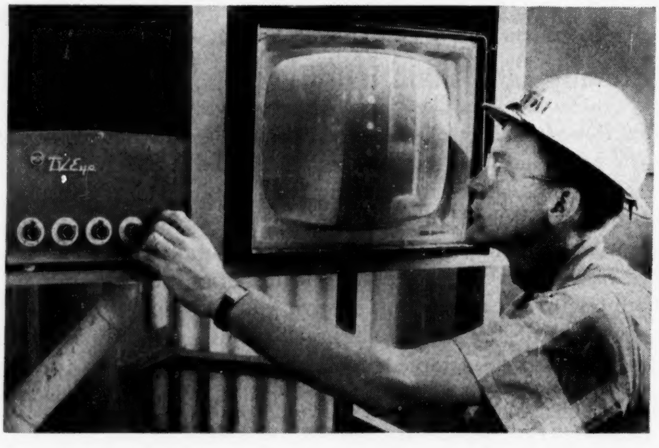
Pneumatic input and output linked electrically.

A new industrial-instrument transmission system eliminates transmission lags. Pneumatic control signals are transmitted electrically over a two-wire link. The output pneumatic signal at the receiving end exactly duplicates the input pneumatic signal.

System has no lost motion, hysteresis or dead spots. It eliminates need for long runs of copper, plastic or other types of air tubing. There are no electronic tubes, transistors or intermittent contacts so that life is unlimited. Energy level at any point in the system is far below the level that might spark an explosion of hazardous gases.

Transmitter requires low voltage d.c. and air pressure. The pressure signal is applied to a bellows which moves a beam affecting the separation of a pneumatic nozzle flapper. Change in nozzle back pressure applied through a diaphragm changes the resistance of a force-sensitive element. Change in resistance produces the change in transmission current needed to rebalance the beam through a pot coil. The d.c. output of 3-15 ma. is directly proportional to the input control signal pressure of 3-15 psi.

The receiver is very similar in construction. — **Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 North 4th St., Philadelphia 33, Pa.** **158B**



TV Eye Channels Gage Reading to Control Room

First in Texas City, this closed-circuit TV system enables Monsanto's Power Dept. operators to see a water-level gage that is three stories above the control room. System was installed recently as part of a new demineralizer unit and boiler. Supplying ½ million lb./hr. of triple distilled water, the demineralizer is the largest of its type in existence. The TV circuit checks boiler water level despite interference which prevents use of mirrors.—Radio Corp. of America, Camden, N. J. 158A

Infrared Analyzer

Moderately priced for continuous-flow analysis.

The new Lira model 200 electronic infrared analyzer is a simplified instrument designed to meet most industrial requirements at lower cost. It can solve the great majority of problems where there is need for quick and accurate analysis of a single component in a simple or complex mixture of gases or liquids.

Instrument operates on the principle of direct deflection rather than electrical null balance. It can be used with an integral indicating meter as well as a recorder.

The signal from the detector cell is fed directly to an indicating meter and/or a recording potentiometer. This permits compact assembly yet the instrument is essentially as versatile as more expensive instruments. And the degree of sensitivity is entirely adequate for most problems.—**Mine Safety Appliances Co., 201 North Braddock Ave., Pittsburgh 8, Pa.** **158C**

Flow Regulator

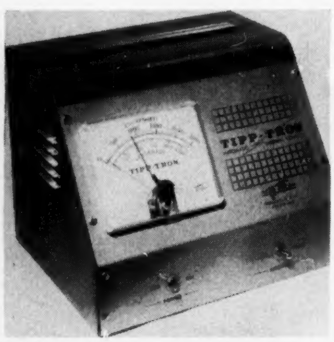
Now has power operator for remote adjustment.

The Kates flow-rate regulator now can be operated either remotely and/or automatically. Compact and extremely accurate power operators have been

selected for adjusting the standard Kates regulators. They can be integrated into any standard-range pneumatic control system with either automatic or manual remote signals.

If control system air should fail, the Kates regulator can be returned to manual operation merely by loosening two cap screws. On normal duty, the power operator provides infinite adjustment throughout the regulator's range.

The Kates regulator is a complete flow regulating system in itself. Action is claimed to be inherently faster and more stable than flow control systems that include air-operated valves. **—W. A. Kates Co., 430 Waukegan Rd., Deerfield, Ill. 158D**



Temperature Control

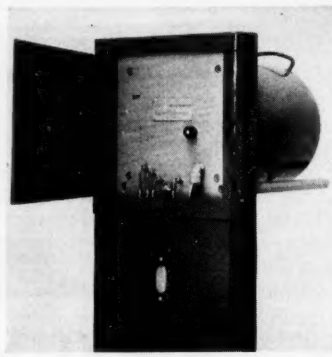
Monitors and controls from 200 to 3,000 F.

With the Tipp-Tron controller you can prevent process and equipment temperatures from rising or falling past preset limits. Control accuracy is held within 2% of dial settings.

The Tipp-Tron is supplied in 10 ranges of temperature, calibrated both in Fahrenheit and Centigrade. Either on-and-off or locking control action may be selected.

With on-off, the device initiates its desired control action when the temperature reaches the preset limit. But it continues to test the temperature periodically. If the heat reaches a permissible level, the Tipp-Tron stops controlling auxiliary equipment while still indicating temperature.

With locking control, the device must be reset manually each time the temperature reaches the control point.—**Tipp Mfg. Co., Tipp City, Ohio. 160A**



Process Refractometer

Improved version controls blending and fractionating.

An improved process refractometer, Type 38-202, can monitor continuously the refractive index of liquid process streams under adverse environmental conditions.

Designed for around-the-clock operation, the instrument is housed in a pressed-steel bell for Class I, Group C hazardous locations. Because unit is compact, it only needs 8 sq. ft. of floor area.

An insulating barrier around the entire optical measuring unit prevents interference from rapid ambient temperature changes. A heat exchanger maintains stability of sample temperature. And a pressure equalizer maintains the "locked-in" standard at the same pressure as the flowing sample.—**Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif. 160B**

Level Gage

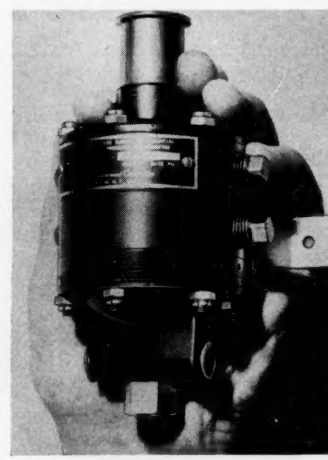
Indicates level magnetically in hazardous areas.

A new magnetically actuated level gage is recommended where glass gages cannot be used, such as installations where explosion or fire may result if any gas escapes. Also, the gage can indicate interface.

Gage has a guided float in a stainless-steel tube. Attached to the float is a magnet which floats exactly at the meniscus.

Outside the tube is a series of magnetic wafers on hinges. Those that are not at same level as the float line up as an essentially continuous marker. Those above the float point down, those below point up. Different colors on opposite sides of the wafers produce a clearly indicated mark at the location of the float.

The float is designed for each specific installation to take into consideration pressure, temperature and specific gravity.—**Jerguson Gage & Valve Co., 87 Fellsway, Somerville 45, Mass. 160C**



Flow Transmitter

Offers low-cost check on previously unchecked flows.

Now, sources of steam, water and air in your plant can be cost-accounted easily and economically with the new 200T fixed-range differential flow transmitter. It can make your plant process control pay increased dividends where more expensive control equipment has not been recognized previously as economical.

Made of brass, the new transmitter has a maximum working pressure range of 150 psi. at 150 F. max. Air supply pressure should be 20 psi. at 0.10 scfm. Output pressure range is 3-15 psi. Ranges are 0 to 50, 100, 200 and 300 in. of water.—**Taylor Instrument Companies, 95 Ames St., Rochester 1, N. Y. 160D**

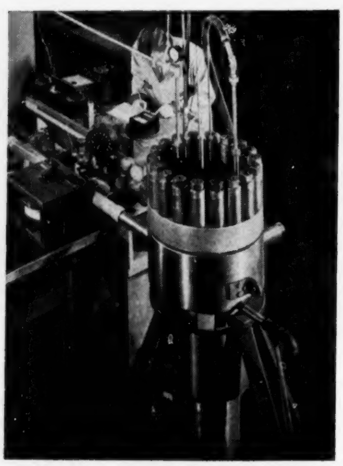
Multi-Stage Compressor

For use with air, ammonia and most hydrocarbons.

A new multi-stage centrifugal compressor in five casing sizes covers capacity ranges from 570 to 82,000 cfm. per casing with discharge pressures to 950 psi.

Casings and diffusers are split horizontally at the centerline with no bolting of the diffusers to the casing. The bearings are mounted external to the casing and are open to atmospheric pressure.

Large bleed volumes in and out of the compressor can be accommodated. This permits handling different levels of refrigeration or stepwise compression of process loads and knockouts with one compressor casing. Heat of compression is reduced by interstage liquid injection cooling. — **Worthington Corp., Harrison, N. J. 162A**



Leakproof Blower

Handles dangerous gases at high temperature and pressure.

A leakproof centrifugal blower has been developed to handle corrosive, toxic and radioactive gases under extreme conditions. It will handle 20 cfm. of gas having a specific gravity of 6 and will develop a 150-ft. head in a 2,000-psi. system. It can operate at gas temperatures up to 500 F.

Unit consists of a centrifugal blower and canned motor sealed in a heavy stainless-steel enclosure. The motor rotor and bearing components are in the lower portion of the unit which is filled with water.

Fluid-piston radial and thrust bearings make possible the leakproof design. An auxiliary pump impeller mounted on the main impeller shaft of the blower pressurizes the bearings. Water level is maintained by adding pure water at the bottom of the unit and tapping it below the interface seal.—**Allis Chalmers Mfg. Co., Milwaukee 1, Wis. 162B**

Spray Nozzle

Large size for cooling and washing operations.

A new, large-capacity flat-spray nozzle, the 2-U-Veejet, is now available. Supplied in a choice of two types of spray angles, this nozzle can discharge from 73 gpm. at 15 psi. to 330 gpm. at 300 psi. It is designed for heavy duty cooling and washing operations.

Nozzle is designed free of cores, vanes or obstructions of any kind. It is made with a 2-in. male pipe connection. Standard material is brass but it can be supplied in other materials to order.—**Spraying Systems Co., 3201 Randolph St., Bellwood, Ill. 162C**

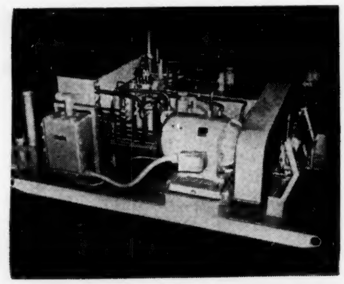
Aluminum Pipe

Is gaining wide use for temporary pipelines.

In the oil-producing areas, aluminum pipe is gaining wide acceptance for temporary pipelines. At least three times the footage per lb. compared to steel makes aluminum pipe economical in original cost. Savings in labor, time and maintenance mean continuing cost advantages.

Seamless aluminum pipe is made of high-strength alloys that stand up under rough usage and resist denting.

On oil-field service handling oil, water, gas or air, this pipe can be installed with three men at the rate of 1 to 1½ hr. per mi. This is more than a 10 to 1 saving compared to the 46 man-hr. required to lay 1 mi. of the same size steel pipe.—**Reynolds Metals Co., 2500 South 3rd St., Louisville 1, Ky. 162D**



Compression System

Provides high-pressure air or gas for development.

The design and testing of systems and processes that involve high pressure can be expedited and simplified through use of the new Cardox central compression system. Air or gas can be delivered continuously at any required pressure between 3,000 and 12,000 psi. Capacity is 54 scfm. of air with a minus 70 F, or lower, dew point.

The standard system is a semi-portable, self-contained unit mounted on structural-steel skids. Included are a compressor, a 50-hp. electric drive, controls, suitable filtering and drying equipment and storage vessels.

The principal components in this system have been proved by nearly 20 yr. operation supplying the high-pressure air used in the Airdox "non-explosive mining method" of breaking up coal at the mine face.—**Cardox Corp., High Pressure Air Div., 307 North Michigan Ave., Chicago 1, Ill. 162E**

For More Information...

about any item in this department, circle its code number on the Reader Service

Postcard inside the back cover.

Coated Fabrics

Teflon on glass provides unique properties.

Teflon-coated glass fabrics offer unusual heat resistance, mechanical strength and extreme toughness. Under heat and pressure, the chemically inert fabrics have low flow.

From this material can be formed diaphragms or liners for hydraulic applications where heat and/or chemical resistance is required. The material remains pliable down below −100 F. and remains inert up to 390 F.—**Shamban Engineering Co., 11617 West Jefferson Blvd., Culver City, Calif.** **164A**

Fibrous Insulation

Unusual properties stem from volcanic origin.

Made from Basalt volcanic rock, the new Basaltwool fibrous material possesses remarkable acoustic and heat insulating properties. Fibers approximately 20 microns in dia. by 18 to 36 in. long permit Basaltwool to be used in mat form without use of a binder.

Basaltwool will not burn or support combustion. Exhaustive tests show that it will withstand temperatures up to 1,700 F. for short periods without breaking down.

The unusually long fiber lengths and wire binding of the batts enable Basaltwool to stand up well under severe air abrasion. Batts are available in densities from 3 to 6 lb./cu. ft., and in widths and thicknesses for most heat and sound insulating applications.—**Thermo-Sound Products, Div. of Kittell-Lacy, Inc., 10816 East Fawcett Ave., El Monte, Calif.** **164B**

Pipe Insulation

For wide temperature range, is chemically inert.

Molded Kaytherm insulation for steam and hot process piping withstands temperatures up to 1,350 F. It is flame-resistant, chemically inert and insoluble in water.

Kaytherm insulation is made by reacting lime and diatomaceous earth to form hydrous calcium silicate which is bonded together with asbestos fibers. It exhibits many of the favorable characteristics of fine concrete such as exceptional strength, wear resistance and unusual dimensional stability.

This pipe insulation comes in a variety of thicknesses from 1 to 4 in. in half-cylindrical sections and segments 36-in. long. It can be cut easily and worked with ordinary tools.—**Keasbey & Mattison Co., Ambler, Pa.** **164D**

Insulation Fastenings

Expand and contract, prevent insulation damage.

Now you can prevent damage to insulation through use of Breather Springs in the band fastenings.

Actually, these springs provide two-way protection. Danger of damage during installation is much less because when the Breather Springs start to stretch, the applicator knows his bands are tight enough. Then once installed, these springs expand and contract to allow for expansion and contraction of hot tanks, towers and vessels.

Each spring can expand from an initial length of 4 in. to a fully expanded length of 16 in. They are made from 0.105 in. dia. Type 302 stainless steel. —**Techalloy Co., Inc., Rahns, Pa.** **164E**

Storage Silos Protected by Plastic Coating

Five of these 60-ft. concrete silos at Pittsburgh Plate Glass Co.'s new Cumberland, Md. plant have been coated internally with a protective plastic coating. Silos store glass raw materials—soda ash, sand, limestone and dolomite. Surface was washed first with acid, then primed with two coats of special chlorinated rubber. Eight finish coats of latex emulsion neoprene coating were applied over the primer to a thickness of 12 mils. Coating resists abrasion, also dusting or spalling of the concrete.—Tank Lining Corp., 246 Washington Rd., Pittsburgh 16, Pa. 164C

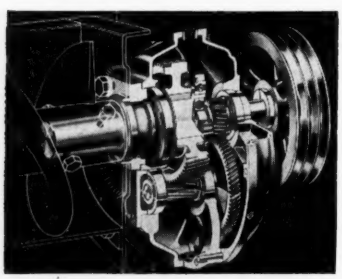
Heavy-Pipe Bender

Easily transported, bends pipe 6 in. and larger.

A new series of large pipe benders makes possible cost savings by bending large pipe on the job in the field rather than welding sections together, or doing the bending in the fabricators plant.

Device can bend pipe 6 in. and larger up to 90 deg. in one single setting. It takes 3 min. actual bending time, with a 2-hp. motor pump, to bend 8-in. pipe 90 deg. in the field.

Frame of the bender can be folded together onto the top of the hydraulic ram. This makes the device easy to assemble or disassemble and practical to transport from shop to job. In the large-capacity field, this bender is claimed to be lightest and lowest priced.—**Tal Bending Equipment, Inc., Milwaukee 2, Wis.** **166A**



Screw-Conveyor Drive

Speed reducer bolts directly to conveyor trough.

A new speed-reduction unit has been designed especially for screw conveyors. The Screw-King drive is a compact unit with flange adapter that permits bolting directly to the trough end of a screw conveyor. This eliminates any tendency to wobble.

The Screw-King reducer provides a direct drive shaft for the screw conveyor, eliminating the need for a separate drive-end shaft. Drive-shaft support bearings are an integral part of the unit. A double-purpose, highly efficient dust seal eliminates the need for an auxiliary seal ordinarily used when dusty material is being conveyed.

The output shaft fits into the pipe of a standard 6, 9 or 12-in. screw having a bore of 1½, 2, or 2 7/16 in. The input shaft is driven through short-center V belts by any motor desired.

Screw-King drives are made in three sizes from ½ to 10 hp., each with three reduction ratios: 5 to 1, 13 to 1 and 20 to 1. Conveyor speed can be varied from 15 to 290 rpm.—**The American Pulley Co., 4200 Wissahickon Ave., Philadelphia 29, Pa.** **166B**

Gear Motor

Can be shaft mounted, good for remote control.

A new shaft-mounted gear motor provides remote and automatic control for variable-speed drives, valves, pumps, feeders and other types of machinery. Called the Shaftrol, unit mounts on shafts from ¼ to ⅞-in. dia.

Both the housing and cover of the Shaftrol are made of aluminum, hence the unit is light and compact. It is furnished with a torque arm or torque plate with resilient mounting that absorbs any runout that may be present in the shaft to be controlled. When used on rising stem valves, the Shaftrol torque plate is fitted with linear bushings to allow axial movement.

There is a wide choice of gearing ratios to vary output speeds and torques. Speeds range from ½ to several hundred rpm. and torques from a few in.-oz. to several hundred in.-lb.—**The Jordan Co., Inc. 3235 West Hampton Ave., Milwaukee 9, Wis.** **166C**

Cargo Light

Makes for easier freight handling in dark areas.

High-intensity light is possible inside freight cars or other dark areas with the new Hoffman cargo light.

The unit will accommodate two bulbs up to 200-watt size. Bulbs are supported in rubber-mounted sockets to resist shock. They are protected by plated steel reflector guards, which may be rotated to direct the light.

The lamp guards and the 14-gage steel body are completely grounded and the unit is made to JIC electrical standards. The cargo light is 17½ in. long and weighs 9 lb., including the cord. —**Hoffman Engineering Corp., Anoka, Minn.** **166D**

Silicon Rectifiers

Miniature 10 kw. size for wide variety of power uses.

Developed under Air Force contract, a new series of miniature silicon rectifiers can satisfy a wide variety of power needs. Applications include on-the-spot conversion of a.c. to d.c. current for motor drives in automation equipment, elimination of rotary converters driving d.c. motors and supply of power for computers. A single rectifier can supply the power needs for a 15-hp. motor.

These Type 4JA60 silicon rectifiers can operate in ambient temperatures from −65 to 200 C. In most circuits, they have efficiency ratings of 99%. They may be combined to allow power output ratings of 1,000 kw. or more.—**General Electric Co., Electronics Pk., Syracuse, N. Y.** **166E**

For More Information...

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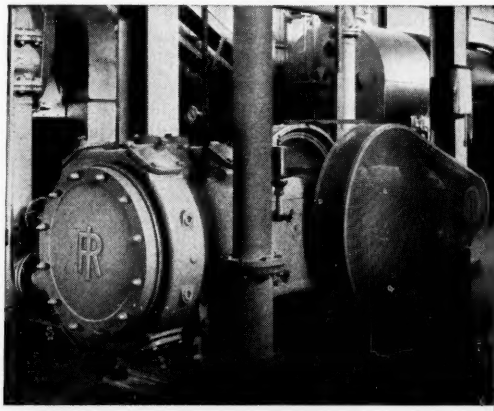
EVACUATE

✔ Continuously ✔ Dependably ✔ Economically



WITH

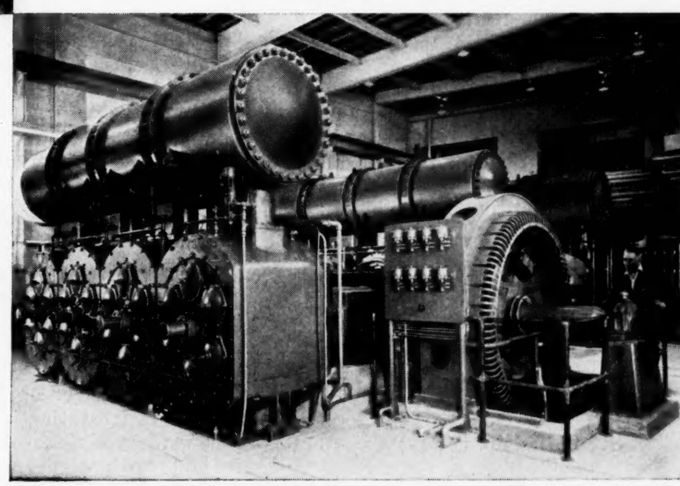
HEAVY-DUTY IR VACUUM PUMPS

...now available in sizes from 7½ hp to 2000 hp, for vacuums down to 29.8" Hg

(Air-cooled units . . . ½ to 7½ hp)

Ingersoll-Rand two-stage ES vacuum pump serving evaporators in a large salt company plant. These horizontal, heavy-duty, single-cylinder units are available in piston displacements of 114 to 3140 cfm, for vacuums down to 29.2" Hg single-stage and 29.8" Hg two-stage.

Each one of three 2000-hp Ingersoll-Rand HHE vacuum pumps has a piston displacement of 51,508 cfm. These units exhaust air from large test chambers used to simulate high altitude conditions.



Ingersoll-Rand reciprocating dry vacuum pumps are designed and built to give dependable performance under any or all of the following conditions:

1. Wherever continuous heavy-duty, full-load service is essential.
2. Where power cost is an important factor.
3. In plants where supervision is limited.
4. Where low over-all operating costs must be maintained.

The wide range of standard sizes, with flexibility of cylinder design and choice of electric, steam or gas-engine drive, makes these heavy-duty units adaptable to practically all vacuum requirements for handling clean, dry air or gases. Cylinders are normally equipped with I-R Channel Valves—known the world over for quiet, efficient operation and remarkable freedom from maintenance.

Ingersoll-Rand also builds a full line of steam jet ejectors. I-R engineers can select the reciprocating or centrifugal pump, or steam-jet ejector, or combination of these that will give the most economical vacuum production for any capacity requirement.

Your I-R representative will be glad to give you complete information on the vacuum equipment best suited to your needs.

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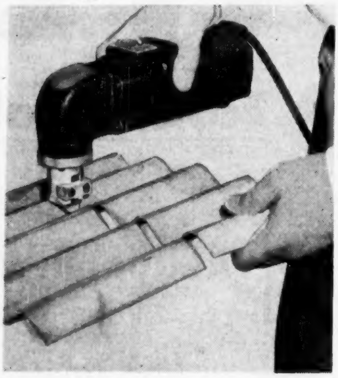
COMPRESSORS • GAS AND DIESEL ENGINES • ROCK DRILLS • PUMPS • TURBO-BLOWERS • AIR AND ELECTRIC TOOLS



Metal Cutter

Eases the cutting of corrugated sheet metal.

A newly developed portable metal-cutting nibbler cuts corrugated sheet metal and small diameter duct or sheet metal pipe without distorting, curling or flattening the corrugated curves on either side of the cut.

A special nose piece and die holder are set at right angles to the body to permit easy handling as the tool rolls over the curves of the corrugated metal. Also, the tool can cut diagonally across the curves. Circles down to 2-in. dia. can be cut without distorting, flattening, or curling of the corrugated metal.

Weighing only 7.5 lb., nibbler cuts 33 in./min. of 16-gage metal.—**Fenway Machine Co., Edgemont & Clementine St., Philadelphia 34. Pa. 168A**

Pump Seal Tool

Helps you prepare stuffing box for mechanical seal.

With the new BJ stuffingbox refacing tool you can prepare a smooth gasket surface on the stuffingbox end to assure proper performance of the mechanical seal.

Consisting of a tool bit and holder, the new tool machines the stuffingbox end at right angles to the shaft axis. The tool bit holder mounts on the shaft with the tool bit against the stuffingbox end. The bit is adjusted to the bore and is worked outward by turning the shaft with a Stillson or strap wrench.

Available in three standard sizes to accommodate shafts from $\frac{3}{4}$ to 3 in., tool is chrome plated and shipped complete with wrenches and two extra tool bits.—**Byron Jackson Pumps, Inc., Box 2017A, Terminal Annex, Los Angeles 54, Calif. 168B**

X-Ray Method

Faster and cheaper than conventional X-ray technique.

A new, faster and lower-cost method for producing X-ray images promises to supplement and partially supplant the use of film in industrial X-ray work.

Advantages of the new xeroradiography are that the process is entirely dry, plates can be "erased" and used over and over again, the images are extremely detailed and only 20 to 45 sec. elapse from the time the exposure is completed to the time a plate is ready for viewing. Cost of producing a xeroradiographic image on a plate is estimated at around 50% less than for film, for quantity production.

X-rays that pass through the object being inspected partially discharge electrostatic charges from a selenium-coated plate in inverse proportion to the density of the X-rayed object. The latent electrostatic image is then made visible by spraying the plate with powder which adheres to the charged areas.—**General Electric X-Ray Dept., Milwaukee 1, Wis. 168C**

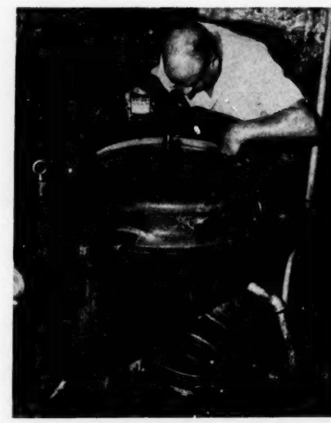
Plastic Ladder

Combines qualities of metal and wooden ladders.

A sandwich construction of glass fiber and Laminac polyester resin are utilized in a new lightweight ladder. In this ladder are found the superior strength-to-weight ratio of lightweight metal ladders combined with the non-conducting qualities of dry wood ladders.

The resulting ladder is ideal for use in power and electrical work and may be used under all weather conditions with complete safety. In addition, this ladder is not affected by corrosives.

Tests have shown this ladder to withstand 650 lb. resistance to rotation in the side rail up to an applied torque of 718 lb.-in. When tested at 50% relative humidity, the ladder did not break down when the maximum voltage of 120,000 v. was applied between the rungs. Approximate weight is 2 lb./ft.—**Putnam Rolling Ladder Co. Inc., 32 Howard St., New York, N. Y. 168D**



Plastic Metal

Soft plastic-steel mixture hardens to rigid mass.

Many pieces of damaged metal can be repaired with Devcon plastic steel, according to the manufacturer. Consisting of a combination of 80% steel and 20% plastic, Devcon is as easy to use as modeling clay. Yet two hours after addition of a special hardening agent, the mixture becomes a rigid, tough, strong, steel-like mass. Once hard, it can be sawed, drilled, threaded or ground with regular metalworking tools.

Devcon is highly resistant to most acids, alkalis and chemicals, it is said. Devcon A is a putty-type material that can be applied to a vertical surface and will not run or sag. Devcon B is a viscous liquid that can be poured. With either type, there is practically no shrinkage during hardening and, once set, they are durable and permanent.—**Devcon Corp., Danvers, Mass. 168E**

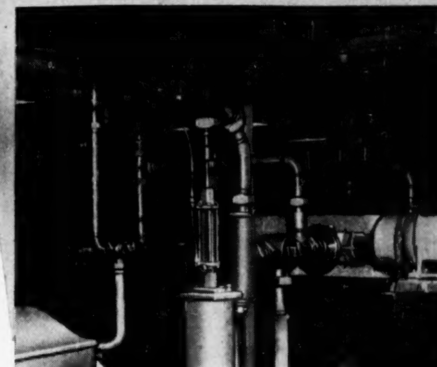
TRI-CLOVER

Stainless Steel Fittings help control quality at A. B. DICK COMPANY plant

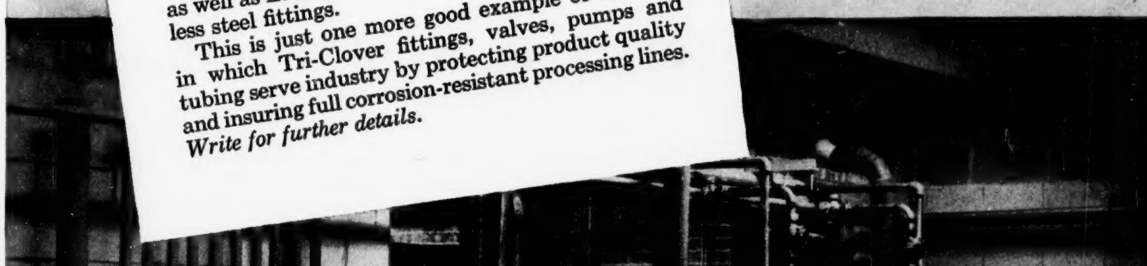
A. B. DICK® is a name known for highest quality duplicating machines, folding machines, and impression paper. At their ultra-modern plant in Chicago, this progressive company makes certain that their reputation for quality is protected in all phases of operation.

In making aqueous base clay paper coatings, for example, A. B. DICK Company makes extensive use of Tri-Clover Division's sanitary type stainless steel fittings, compression valves, and plug valves, as well as Ladish Co. tube O.D. butt welding stainless steel fittings.

This is just one more good example of the way in which Tri-Clover fittings, valves, pumps and tubing serve industry by protecting product quality and insuring full corrosion-resistant processing lines. *Write for further details.*



Shown below is the mixing room where aqueous base clay paper coating is prepared, using Tri-Clover fittings and valves. The view above is a close-up taken from underneath the coating mixer, showing Tri-Clover fittings, compression valves, plug valves and air-actuated kettle valve.



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LADISH CO.

Tri-Clover Division
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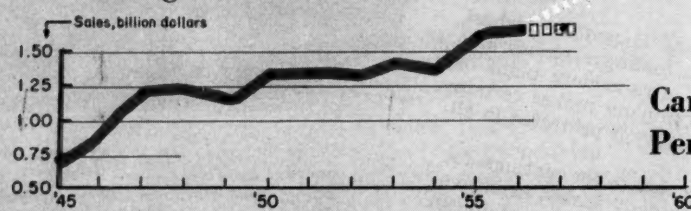
Paints and Varnishes Are Riding Another Plateau



Can Installment Buying Perk Up Sales?

Paint Sales Level Off Again, Need New Boost

Roslyn K. Gitlin, Assistant Editor

PAINT, varnish and lacquer sales have nearly doubled in ten years, climbing from $900 million to almost $1.6 billion in three waves—in 1947, 1950 and 1955. In between the waves: Two nearly smooth periods when sales floated, waiting for the next groundswell to carry them to higher levels.

Right now it looks as if we are already in another leveling-off period, one that might stretch out two or three years more unless something comes along to prod paint sales upward once again. Installment buying, the gimmick that's built a fire under so much of our buying—but which hasn't been used to push paint—might be the "something" to do it.

► **Boom-Boom** — In 1955 two booms—one in house-building, another in auto building—jumped annual paint, varnish and lacquer sales from $1.36 billion to $1.56 billion, an all-time high. Though fourth-quarter figures aren't in yet, it's a safe bet that 1956's paint sales were even higher.

But not much higher. Eight-month totals for 1956 show only a 1.9% sales increase over '55, with trade sales up 2.8% and industrial sales up 0.7%. (However, 1957 car models and post-summer upswing of consumer durables should bring industrial paint sales gain closer to the trade sales gain in year-end tallies.)

► **Leveling Out** — As in '55, credit for the '56 sales peak goes largely to home-owner demands and increased automobile production (in the last half). And this year's sales performance will hinge on these markets, too, though the outlook is somewhat less optimistic—". . . good, but no record-breaker."

The reason: tight money. Today's stricter credit terms mean fewer housing starts, slowdown on industrial construction and fewer autos sold in 1957.

So we can perceive a smoothing out of paint sales over at least a three-year span at a $1.5-1.6 billion level. And with no burst in autos or in home building comparable to 1955's in the offing, paint sales may hold steady for some time. Not that this is bad, by any measure. It's just that, as paint people say, it could be so much better.

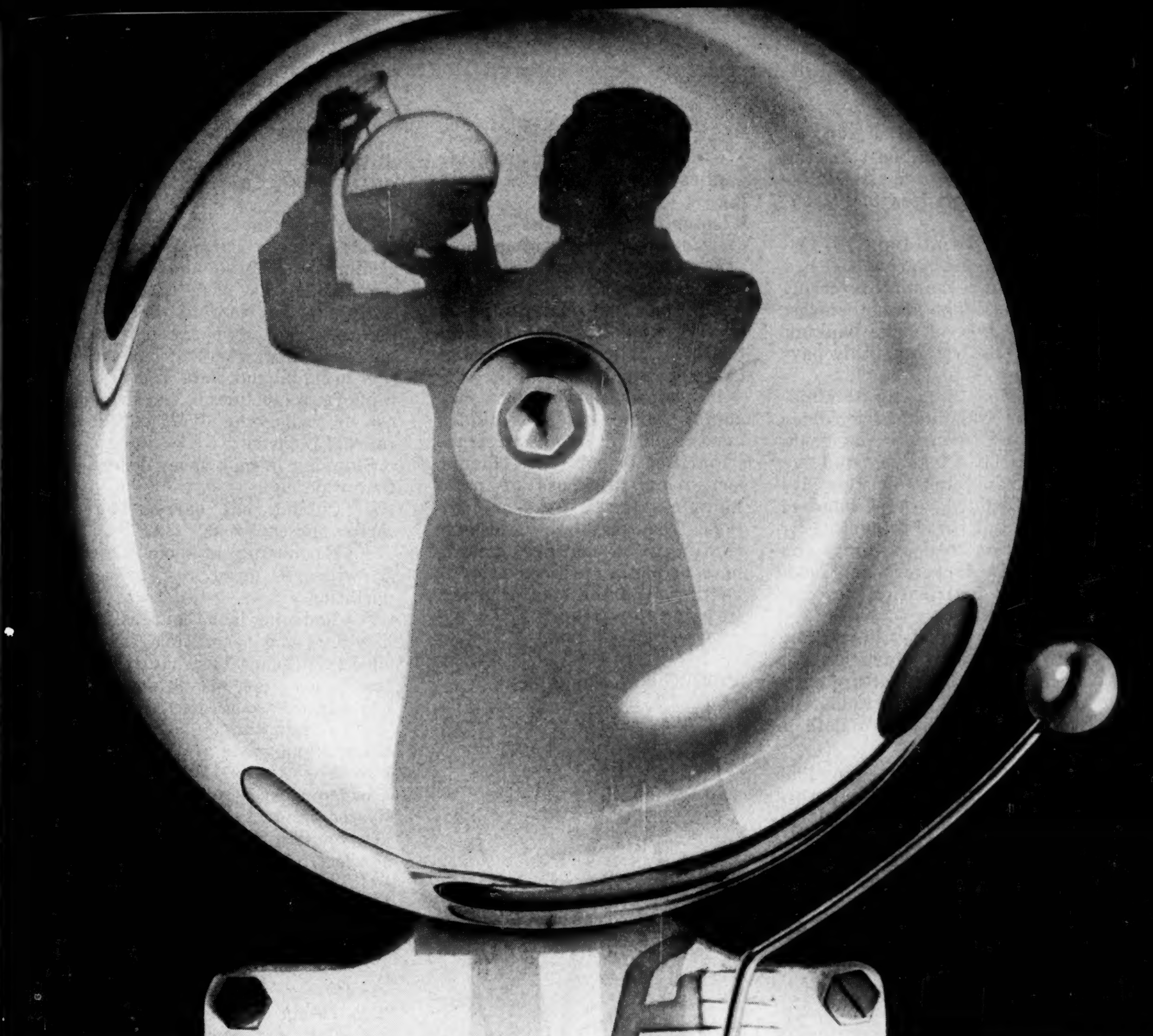
► **Not Enough Oomph**—One reason sales aren't better is because promotion hasn't kept pace with paint technology. Early last year, General Joseph F. Battley, president of the National Paint, Varnish and Lacquer Assoc., decried the fact that, with a present market potential, in his estimation, of $3 billion, paint people have never really "sold" their product as have so many others—on time-payment plans.

If you can buy nearly everything—from tree surgery to storm windows, as one man put it—for the home on time, why not paint? The answer is, of course, that you can. But the paint makers and dealers don't promote it on the so-much-down, so-many-years-to-pay basis.

As a result, the homeowner, faced with a $300-$400 job even if he does it himself, may let repainting his house slide a year, or two, or three. Yet he'll buy a car costing maybe ten times as much, and sleep soundly.

► **Hard Sell Coming**—There have been signs, though, in the last six to eight months that more aggressive marketing methods are on the way:

- National Paint, Varnish and Lacquer Assn. is coming out soon with a manual about selling on time. This is expected



to give a sharp boost to the time-selling program already instituted by retailers and paint contractors.

• Joint Paint Industry Coordinating Committee has worked out a manual on credit approaches. The manual shows, stepwise, how to make banking connections, scale monthly payments, etc.

• Federal Housing Administration has published a folder explaining monthly payments through Title I loans. And the Joint Industry Committee has now circulated several hundred thousand of these to banks (for distribution to depositors) and paint manufacturers and dealers (for distribution to customers).

• Paint industry is working with American Institute of Architects, with furniture manufacturers and other industrial users to keep them up to date on new paint products.

▶ **Latices Still Gain**—*In 1956* the trend in latices was toward *emulsions with finer particles*, and continuing gains over oil-based paints for exterior use on masonry and, most recently, on wood.

Other synthetics moving up: amine-catalyzed finishes, pushing forward at the expense of conventional baked or dryer-requiring finishes; polyamides and hyperoxides over cellulosics.

▶ **Industrial Paints Improve**—On the industrial sales side news is being made, too. Activity has been high in vinyl compounds to protect metal surfaces against corrosion; high-heat resistant paints; nontoxic, nonflammable paint strippers; and hot spray applications (for single, thicker coats). Also moving along are touch-up paints and long-lasting automotive finishes (like Du Pont's Dulux 100 and Lucite, and Martin-Senour's and Sherwin-Williams' fast-drying enamels).

In anticipation of future needs, here are some projects already well along the road to commercial realization:

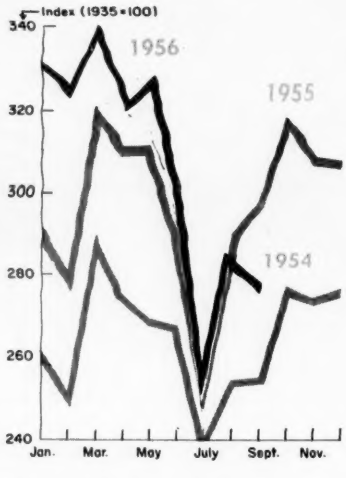
• Flame-retardant foaming paints, using starch and/or urea resins. A paper-thin layer of paint chars and puffs up to $\frac{1}{16}$-in. of foam when heated.

• Urethane coatings—for applications in industrial finishing.

▶ **Isotopes Track Paints**—An indication of the tremendous amount of research still to be done can be seen in an interesting series of projects proposed by Bjorksten Research Laboratories: application of radioisotopes in paint research.

It's hoped that isotopes may supply some of the hidden answers to determining trace impurities in paint ingredients, measuring thickness of paint films, measuring wear of coatings. They may help determine continuity of coatings, cleanliness of metal surfaces prior to coating, and the role of driers in paint.

Chemical Consumption



Consumption by Industries

	Aug. (Final)	Sept. (Est.)
Coal products	9.4	11.3
Explosives	11.8	11.3
Fertilizer	47.8	56.9
Glass	29.1	21.9
Iron & steel	14.9	19.1
Leather	4.0	4.0
Paint & varnish	35.3	30.9
Petroleum refining	32.2	26.7
Plastics	16.8	19.5
Pulp & paper	38.8	35.3
Rayon	24.9	23.4
Rubber	6.5	6.2
Textiles	10.3	9.6
Total	282	276

Shippers Switch to Bulk Delivery

Bulk shipment is no longer the nearly-exclusive transportation medium of the basic big tonnage commodities like coal, iron ore and petroleum. Harried by creeping costs, industries are delivering everything from hydrofluoric acid to liquid chocolate in everything from pipelines to enormous rubber balls, the *Wall Street Journal* reports.

Shipping in bulk saves dollars four ways by

• Cutting out barrel, bag, carton and can costs.

• Permitting, in some cases, a switch to lower cost transportation.

• Reducing labor charges for handling, and permitting, sometimes, in-plant mechanization that saves time, prevents waste and improves sanitation.

• *Eliminating demurrage* charges and waste of box cars.

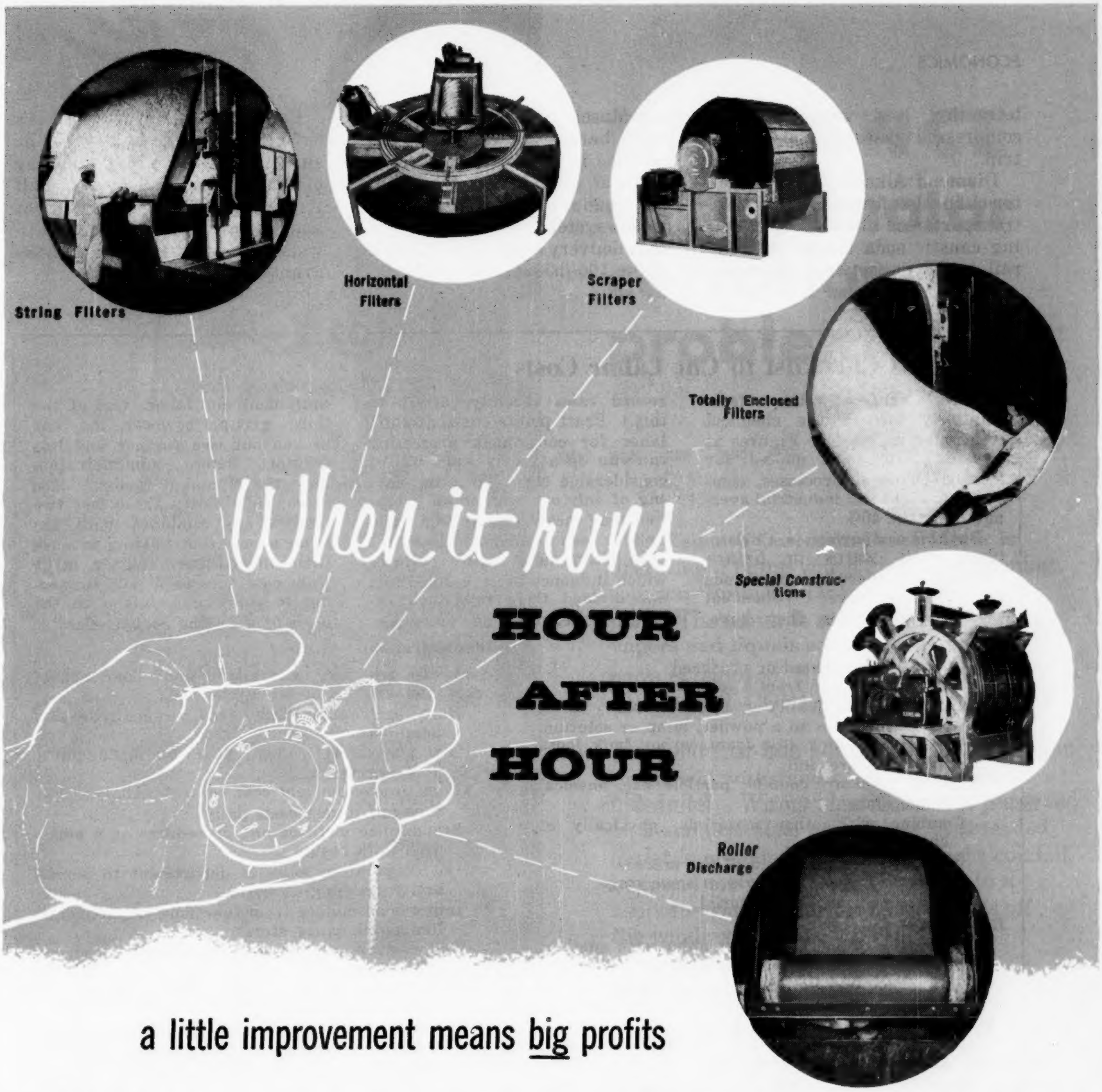
▶ **Bulk Carriers Multiply**—A broadening spectrum of bulk-delivered products uses a host of new hauling devices and freight carriers.

In place of individual sacks, bags, cartons and cans, says the *Journal*, are truck trailers and railroad cars employing pneumatic loading and unloading devices; big rubber balloon-like bins toting up to five tons of material; and heated and pressurized tank trucks and railroad cars. Also on the bulk-lugging job: Self-loading bins put aboard truck trailers or railway flat cars by fork-lift trucks; throw-away corrugated board bulk cartons; and barges and ocean-going tankers.

▶ **How They Cut Costs**—Let's rundown some of the cost-cuts bulk shipping is making possible, according to the *Journal*.

A United Carbon spokesman estimates yearly dollar savings of 25% on shipments of 22 million lb. of carbon black by barge from U. C.'s New Orleans plant to U. S. Rubber's Eau Claire, Wis., tire plant.

Du Pont looks for "substantial" savings over shipping by tank car and drum when it puts into service a specially converted 5,000-ton tanker. The ship will travel between Western seaboard and Gulf Coast ports, carrying



a little improvement means big profits

That's particularly true in filtration, where a few points higher recovery of solubles . . . or 5% less moisture . . . or 1% less impurities . . . soon pays back the entire cost of the filter. There's only one way to get the last ounce of efficiency: *custom designed* filtration . . . a FEinc specialty for 35 years.

FEinc offers you an almost infinite variety of filter types, discharge methods, valve designs, cake washing systems, dewatering devices, internal drainline arrangements, drainage surfaces, enclosures, sizes, speeds and materials of construction.

The cost? FEinc's custom engineering costs no more than ordinary filters . . . and rewards you handsomely day after day, year after year.

Write today for Bulletins or ask for free performance studies

FEinc
FOR A BIGGER YIELD

FILTRATION ENGINEERS, INC.
SUBSIDIARY OF AMERICAN MACHINE & METALS, INC.
155 Oraton Street, Newark 4, N. J.

Custom designed continuous filtration

tetraethyl lead westward and compressed gases on the return trip.

Diamond Alkali's traffic director claims his firm has shaved its transportation bill 50% by shifting caustic soda shipment from rail to barge between Houston and Muscle Shoals, Ala. Each of eight barges now used carries caustic in separate, insulated tanks at over 100 F.

A manufacture of bulk handling systems estimates bulk flour delivery cuts ¼¢/lb. off costs of the 100-lb.-sack method.

Continental Baking says it's saving an average of 10¢/100 lb. since switching to bulk handling of flour, sugar and lard at half its bakeries. Previously, flour and sugar traveled in multi-walled paper bags, lard in steel drums.

Use This Checklist to Cut Labor Costs

Labor's share of total costs is relatively low in the chemical processing industries. Figures as low as 5-10% are quoted for specific chemical processes, compared to a general industrial average of about 40%.

But this comparison is, Christopher Pratt warns in *British Chemical Engineering*, no grounds for complacency. (Chemical profits, trailing, as they have, record sales recently, attest to this.) Pratt points out that shift labor for continuous processing can run up a yearly wage bill of considerable size. Thus the saving of only one man on an operation may mean a saving of three or four men around the clock.

In listing many factors (below) which influence labor costs, Pratt has divided them into such familiar categories as materials, equipment and labor. Out of the third group, however, he has broken out two further and less tangible items: administration and the "human factor." Too often, says Pratt, these last two factors are combined with the labor group, thus tending to mask their importance, and "a large price continues to be paid for trying to run organizations on the basis of a costing convenience."

Materials

- Change amount used or produced.
- Change state, e.g. from a solid to a liquid.
- Change grade, quality or specification.
- Change form, i.e. to a powder, lump or solution.
- Change packaging, to a drum, carboy, bulk, loose or a standard unit.
- Change moisture content, particle size, physical dimensions.
- Combine with other materials, physically or chemically.
- Handle at another stage of the process.
- Leave in process or remove at some stage.
- Replace with another material.

Equipment

- Eliminate an operation or combine with another.
- Reduce or extend equipment used.
- Change present capacity, speed or range.
- Combine or synchronize two or more items to effect redeployment of labor.
- Install larger or better facilities to assist handling, feeding or takeoff.
- Improve arrangements for operating, adjusting, cleaning and maintaining equipment.
- Increase standby or auxiliary plant and facilities.
- Standardize major and auxiliary units.
- Extend measuring, recording and testing devices.
- Use automatic control, self-feed or interlocked equipment.
- Replace batch-operations by continuous operations or vice-versa.
- Use more modern equipment, different in principle or design.

Labor

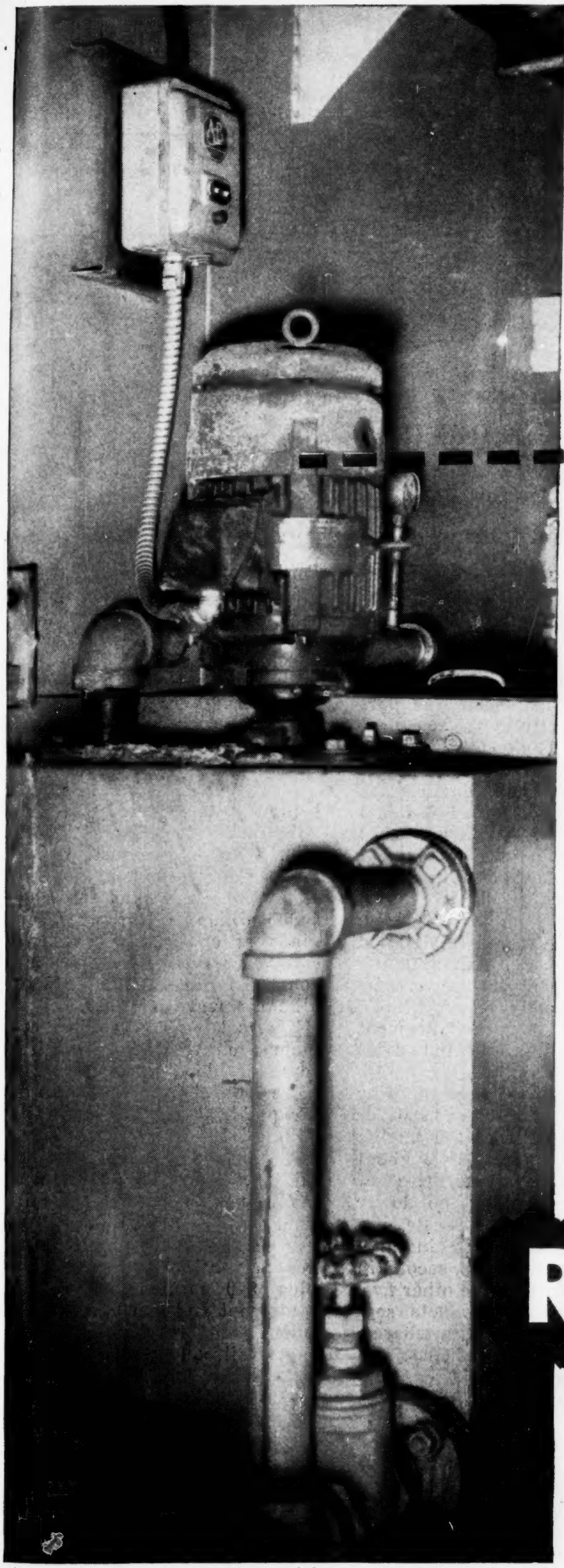
- Eliminate an operation, directly or with a machine.
- Reduce operation, in frequency or degree.
- Reduce workers assigned to an operation.
- Change worker requirements in terms of age, grade, sex, type, physical characteristics, mental ability.
- Increase or reduce indirect labor employed on auxiliary operations.
- Increase or reduce spare labor pool.
- Use shift labor instead of day work, or vice-versa.

Administration

- Insure adequacy of training and experience of management at all levels.
- Help each supervisor and foreman develop administrative ability.
- Give periodic refresher courses for management and supervision.
- Plan production and cost control. Analyze lost time and excess costs daily.
- Standardize methods and procedures on a measured work basis.
- Get coopération of sales department to permit better planning of work.
- Improve assistance from functional departments, like maintenance, stores.
- Reduce overtime, changeovers, range of products, short runs.
- Check closely to reduce bad timekeeping and lost time at all levels.
- Have impartial outside consultants examine procedures periodically and recommend improvements.

Human

- Use a skilled personnel officer to deal with wages, employee problems and working conditions.
- Use job evaluation to establish proper differentials in wage rates.
- Follow merit rating plans to give accurate appraisals of employees and permit frank discussions of abilities and shortcomings.
- Afford opportunity for self-expression through joint consultation, suggestion schemes, etc.
- Afford opportunity to earn extra money by piece work and promotions.
- Offer security and stability through pensions, savings and sickness plans.
- Provide reasonable facilities for meals, relaxation and bodily comforts.
- Minimize industrial fatigue, accident and health hazards.
- Give sound training in details of work.
- Hold periodic refresher courses and reviews of employee records to stimulate maximum interest in the work.



Contract Maintenance Can Cut Costs

Petroleum refiners are shaving maintenance costs by farming out more plant work to contractors, says *Petroleum Week* (Oct. 19, 1956, p. 31).

And well they might, what with maintenance being the largest single item in refinery operating budgets—30-50% of operating expenses. Then, too, longer on-stream times between unit shutdowns for overhaul means inefficient use of a specialized maintenance force which must be kept at full strength to cope with emergencies and turnarounds.

►**Savings Are to Be Had**—It's tough, says *Petroleum Week's* article, to directly cost-compare work done by contractors with that by the refiner's full-time employees. But there are areas where positive savings can be made:

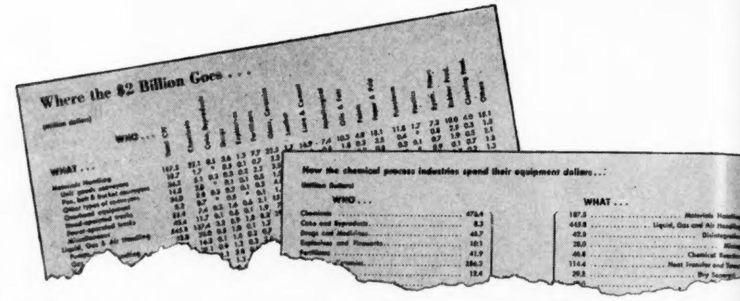
- Reduced payments for "idle time." Contracted maintenance forces are on the payroll only when there's work to be done.
- Expensive overtime held to a minimum.
- Reduced capital investment in maintenance equipment, materials, warehouses and field offices.

►**Routine Jobs, Too**—Contracting is spreading to routine maintenance, too, of late. Tidewater Oil's recently-signed contract with Catalytic Construction covers routine, as well as major, maintenance at the 130,000-b/d refinery at Delaware City, Del.

Union Oil, with more than seven year's experience with contract maintenance, has a contract now with Fluor Maintenance for routine work at its Oleum refinery.

Many companies, though, are still opposed to farming out routine work. In some old refineries with large maintenance forces, layoffs would be necessary if routine assignments were given to contractors—and the labor unions can hardly be expected to go along with that.

Even major maintenance on a contract basis brings beefs. Refinery union men argue that contractor craftsmen get higher rates and that, when outsiders are brought in, regular employees lose out on overtime work.



Did you see our . . .

Equipment Bill Breakdown

Chemical processors itemize expenditures for 230 kinds of equipment—down to the last valve and bubble cap.

The bill adds up to an impressive $2.1 billion (*Chem. Eng.*, Dec. 1956, pp. 272-274). Yet not even this figure tells the whole story. Our data includes equipment for replacement or addition to plants which was purchased directly by the chemical processing companies. Add in equipment purchases made by construction and engineering companies in behalf of chemical processors and you'll find total CPI spending for equipment running close to $3 billion annually.

Scanning our survey's most distinctive feature—its detailed breakdown of total spending into component parts—we came up with these figures:

- The "Chemicals" segment of the processing industries bought $476 million in equipment, 23% of total spending by all industries and the most for any segment. And the buying strength was spread throughout the 18 major categories of equipment—ranking no lower than third in any category. Chemicals was first in nine equipment categories, second in four and third in the other five.
- Petroleum Products segment was second in purchases, with $390 million, and Glass and Ceramics group was a surprisingly strong third with $286 million.
- Five processing segments out of 18 (Chemicals, Petroleum, Glass, Paper & Pulp, Lime and Cement) bought 75% of all equipment.
- East North Central section of the U.S. (Mich., Ill., Ind., Ohio, Wisc.) led—as you might have expected—all other sections with 26% of all equipment purchases. Middle Atlantic states (N. Y., N. J., Pa.) were a close second with 24%. Thus eight states accounted for half of all equipment purchases by chemical processing industries.
- Chemical processors bought more Liquid, Gas and Air Handling equipment ($446 million) and Construction Materials (for equipment but exclusive of piping and tubing—$423 million) than any other kinds of equipment. The two categories between them accounted for more than 40% of all equipment purchases.
- Dust collectors, wet cyclones, electrostatic precipitators, air filters, air cyclones—more often than not the tools of air pollution control—cost the CPI nearly $25 million.
- Sewage disposal cost $8 million. And water treatment before use cost about $10 million.
- Throw in $23 million for fire prevention and protection plus $10 million for safety equipment and you have a tidy layout just for "extras."
- Railroad transportation cost plenty, too. The chemical process industries shelled out $92 million to lease railroad cars (not included in $2.1 billion figure above): $48 million for tank cars, $18 million for hopper cars, and $26 million for box cars. "Chemicals" did $38 million worth of the leasing.

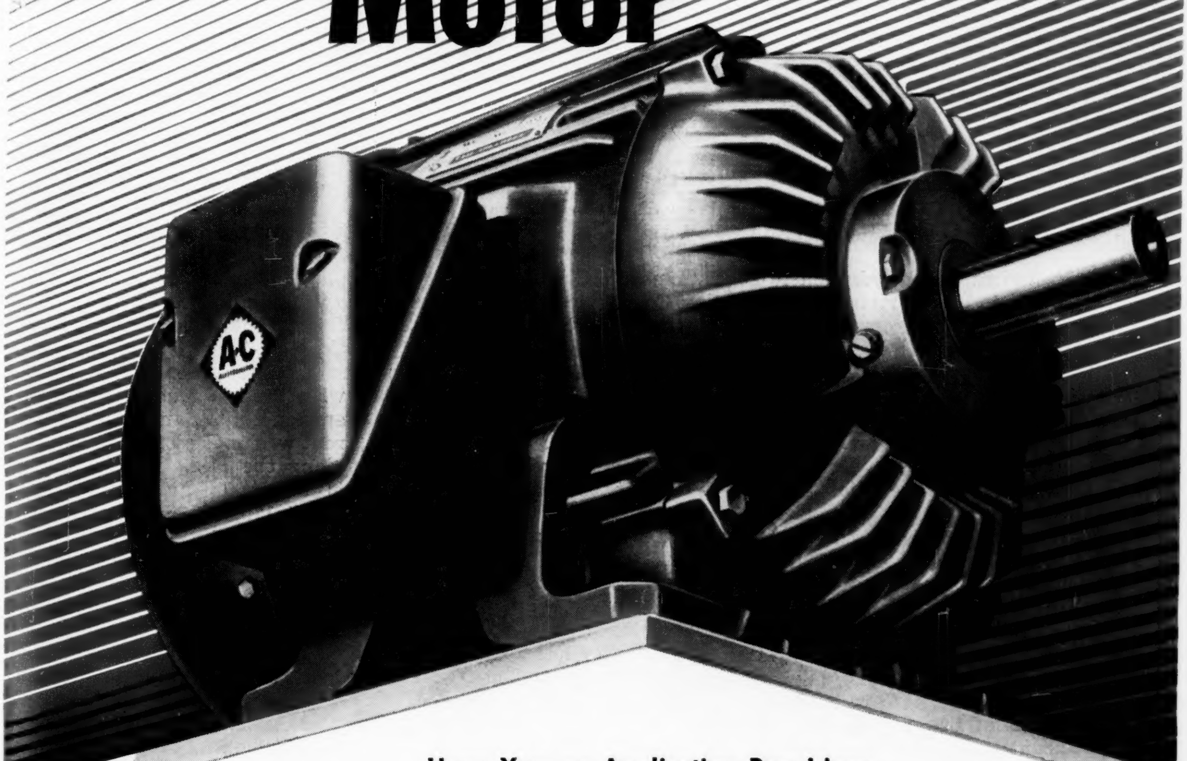
NOW dependable constant speed at less cost

Here's a motor with all the constant speed benefits of synchronous design at initial low cost — with the dependability of an induction motor. It's the NEW *SYNDUCTION* motor, built specially for applications from 1/4 to 40 hp.

DEPENDABLE — Now constant speed, regardless of load or voltage changes, is sure . . . depends only on frequency. *Synduction* motor's simple die-cast rotor has no brushes, collector rings, nor insulated rotor windings.

LOW COST—Simple across-the-line control is all that's needed. Further, design permits use of frames smaller than usual reluctance-type motors. Purchase price is well below that of ordinary reluctance-type motors.

New *Synduction* Motor



Have You an Application Requiring:

1. unvarying speed; **2.** operation of several motors at fixed speed ratios; **3.** adjustable speed with minimum variation at any speed setting? If so, Allis-Chalmers invites your inquiry. Contact your nearby A-C office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin, for Bulletin 51B8440.

Synduction is an Allis-Chalmers trademark.

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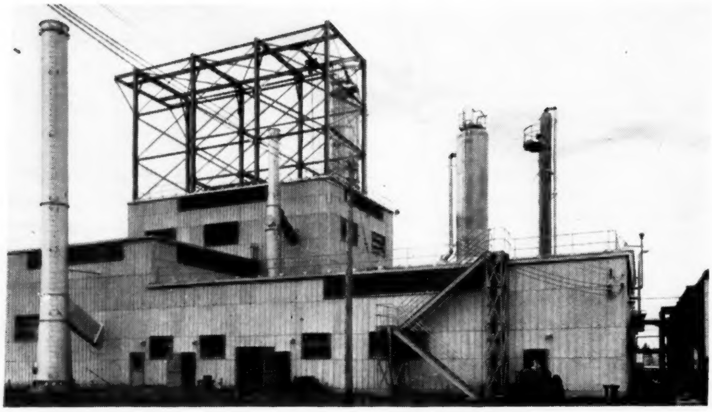
PRACTICE . . .

PROCESS FLOWSHEET EDITED BY T. P. FORBATH



Ammonia plant provides key leach solutions as . . .

Hydrogen Reduction Nets Ni

Scoring its first solid commercial success, hydrogen route avoids usual smelting or electrolysis.

Processes using hydrogen reduction to drop metals from leached ores and concentrates have been shaping up, over the past few years, as vigorous young challengers of traditional reduction operations (e.g., smelting, electrolysis). While most of them have stepped promisingly out of the pilot plant stage only to meet with tempered success, one of the challengers has scored a solid commercial victory.

On stream at Ft. Saskatchewan, Alta., an ammonia-leach, hydrogen-reduction process is now winning 30 tons/day of nickel for Sherritt Gordon Mines from Lynn Lake (Man.) nickel concentrates. And as a handsome pair of extras, the plant turns out 250 tons/day of fertilizer-grade ammonium sulfate, 4 tons/day of copper sulfide. Too, Sherritt Gordon sees the day when commercial lots of coveted cobalt and some metal salts will be added to the list of products turned out.

Painstakingly weaned from lab bench jointly by the Canadians and Chemical Construction Corp. (New York), builder of the installation, the plant came initially on full-capacity stream in mid-1955. But it was only during the past year that the last of its operating kinks were ironed out.

▶ **Why Hydrogen?**—In electing to exploit the concentrates itself, Sheritt Gordon found that, in the relatively modest size required, a smelting plant would cost more than a chemical refinery.

Something of a minor chemical industry has sprung up on the installation's 800-acre site to aid and abet the refinery: (1) a 75-ton/day ammonia plant to provide leach solution and hydrogen; (2) a 2-ton/day hydrogen sulfide plant; (3) a 100,000-gal/day, triple-effect evaporation plant to crystallize ammonium sulfate.

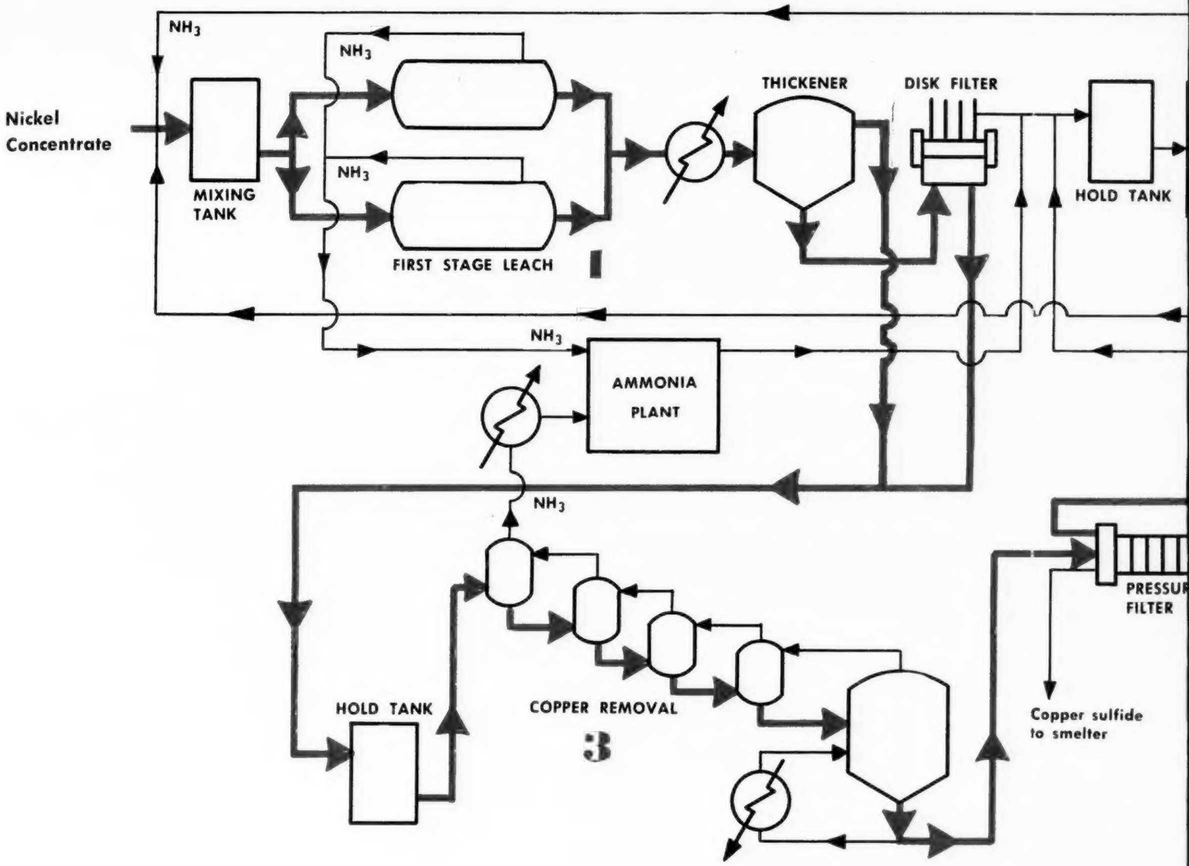
▶ **How Process Works**—Heart of the two-stage, ammoniacal leach system is a group of eight, stainless steel-clad, 17,700-gal. cylindrical autoclaves hooked into two parallel streams of four each (**see flowsheet**). Each is set horizontally and divided vertically into four compartments, each fitted with an agitator. Internal cooling coils and water jackets control the exothermic reaction temperature.

Sized concentrate feeds first to a mixing tank, along with solution and ammonia recycled from the second stage and 100-psig. air. Concentrate slurry then enters the two, first-stage leach autoclaves. Held there for about 6 hr., the concentrate reacts with NH_3 to form the six-amine nickel sulfate complex, ammonium sulfate, soluble copper and cobalt amines and, because of the deliberately short reaction time, unsaturated metal-sulfur compounds. Their presence helps drop out copper sulfide at a later stage. Temperatures are kept in the range of 175 to 185 F.

Stream flows to a 105-ft.-dia. by 8-ft.-deep thickener. Overflow, carrying metal values, goes to metal recovery portion of the plant. Underflow is filtered on a vacuum disk filter. The filter cake is further leached, in the six-tank, parallel-hooked streams of the second stage, with fresh ammonia from the ammonia plant and counter-current wash solution from further along the line. Reaction time is about 18 hr., temperature about 175 to 185 F.

▶ **Getting All Values**—Stream feeds to a second stage thickener and underflow goes to a battery of four vacuum disk filters and three countercurrent water-wash tanks where the last metal values are stripped. Overflow and filtrate from the first filter in the battery recycles to the first-stage. Countercurrent wash solution joins the incoming stream to the second stage leach.

▶ **Cutting Out Copper**—Filtrate from the first-stage leach carries the metal values. Copper must be precipitated first to insure a pure nickel product. By heating filtrate to 250 F., in five pot stills, most of the remaining ammonia is driven off and the



copper reacts with the unsaturated sulfur compounds to drop out as copper sulfide.

Solution flows from pot to pot. Ammonia vapor, driven off the fifth pot by an external heat exchanger, travels in the opposite direction as direct heating for the subsequent pots, and is condensed after leaving the first pot for recovery.

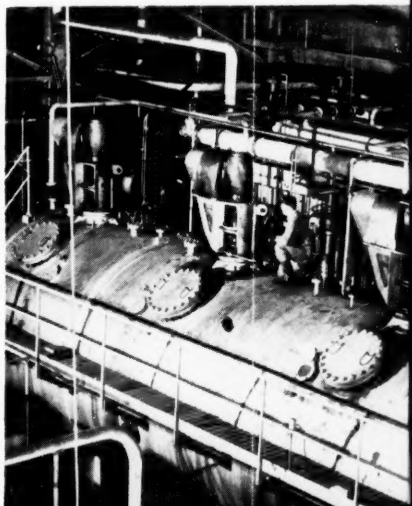
Copper sulfide is cut out of the solution by a pressure-leaf filter. Any residual copper is further stripped by precipitation as sulfide with hydrogen sulfide in two parallel-hooked, 2,500-gal. autoclaves, followed by a second filter. Precipitate returns to first stage leach for recovery of nickel sulfide.

Unsaturated sulfur compounds must be destroyed to prevent nickel sulfide from precipitating during H_2 reduction. They are converted to ammonium sulfate by high-temperature (375 F.) oxidation and hydrolysis in three 3,000-gal autoclaves hooked in series. Passing through a preheater, filtrate enters the first with 700-psig. air for oxidation. Then heated by solution from the third tank, it passes through the next two for hydrolysis.

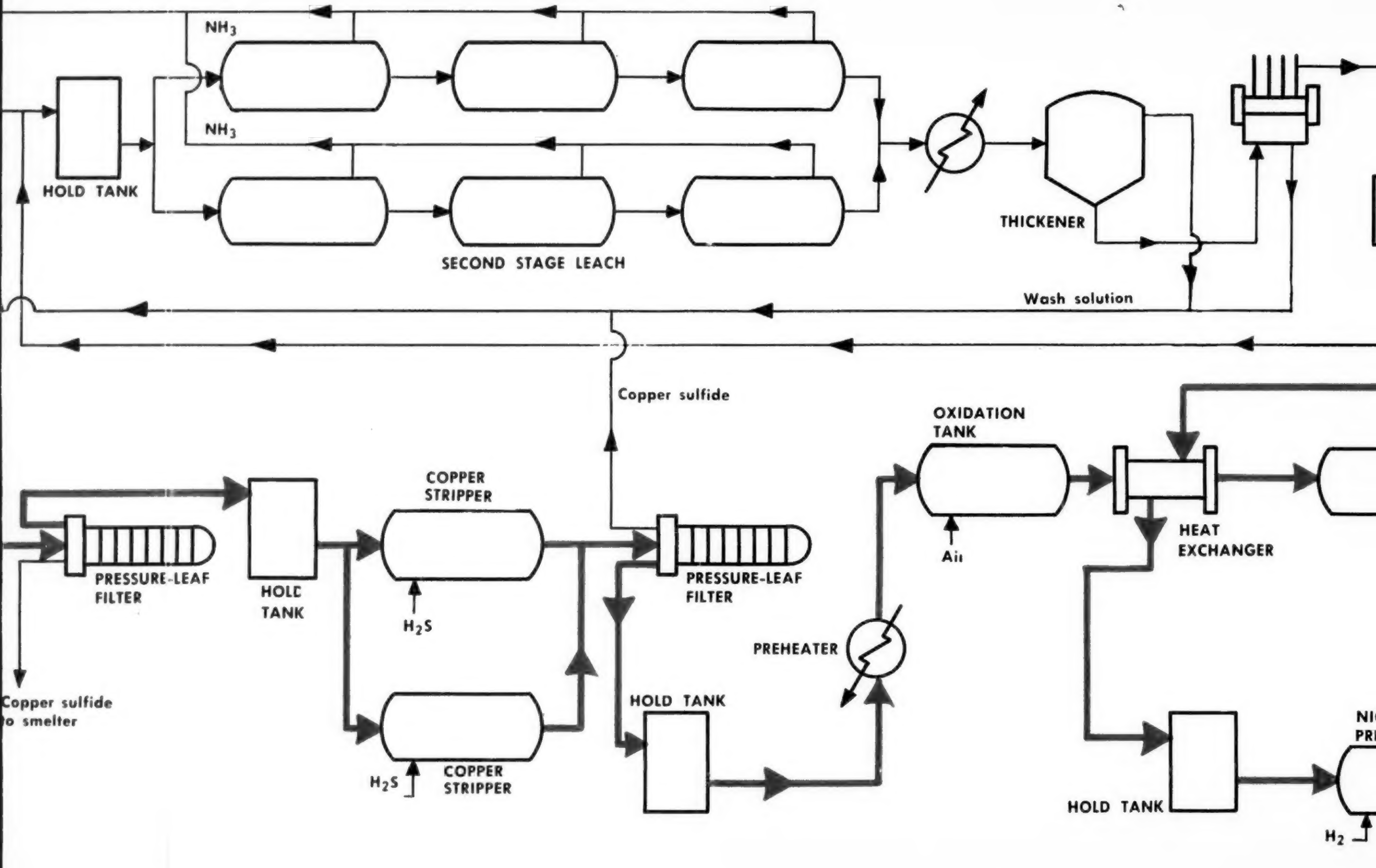
▶**Reduction to Nickel**—Nickel metal drops out at 300-400 F. when agitated with 200-psig. hydrogen. To accomplish this the flow switches from continuous to batch. Hydrolyzed solution discharges from a hold tank periodically to one of four 3,000-gal. autoclaves.

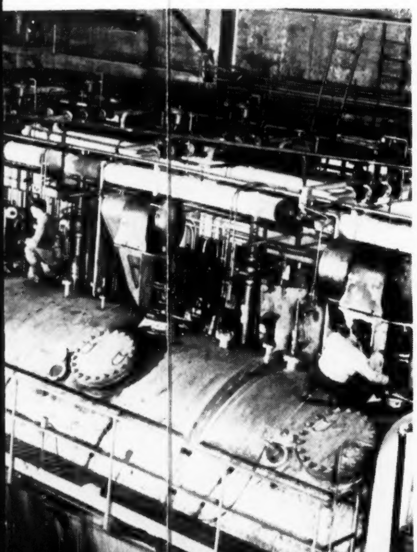
Each batch is decanted of mother liquor, leaving the nickel powder behind to form nuclei for the next batch precipitation. After 20-40 batches the accumulated nickel is washed out with mother liquor and fed to a flash tank. Hydrogen and steam flash off, nickel powder is tapped from the bottom.

Solution goes to cobalt precipitation where hydrogen sulfide at 5 psig. and 155 F. drops out a mixed nickel-cobalt sulfide for cobalt recovery. Nickel powder is washed, filtered and dried.

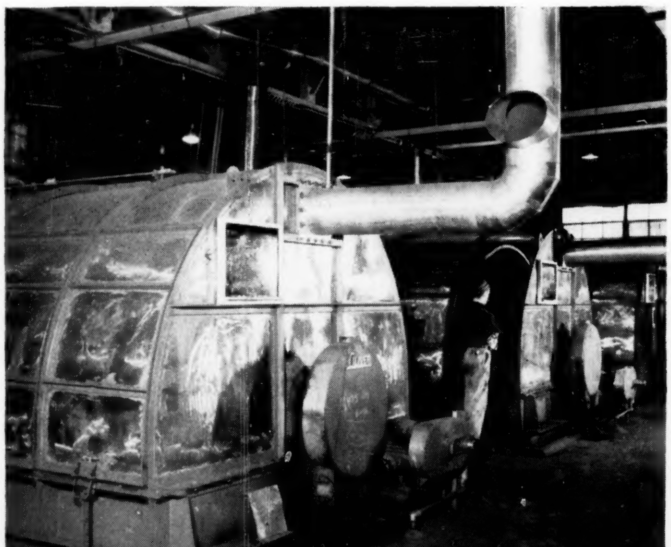


1 FIRST STAGE LEACH: Air, ammo amines, ammonium sulfate, unsaturat

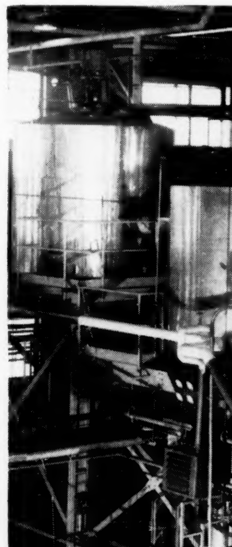




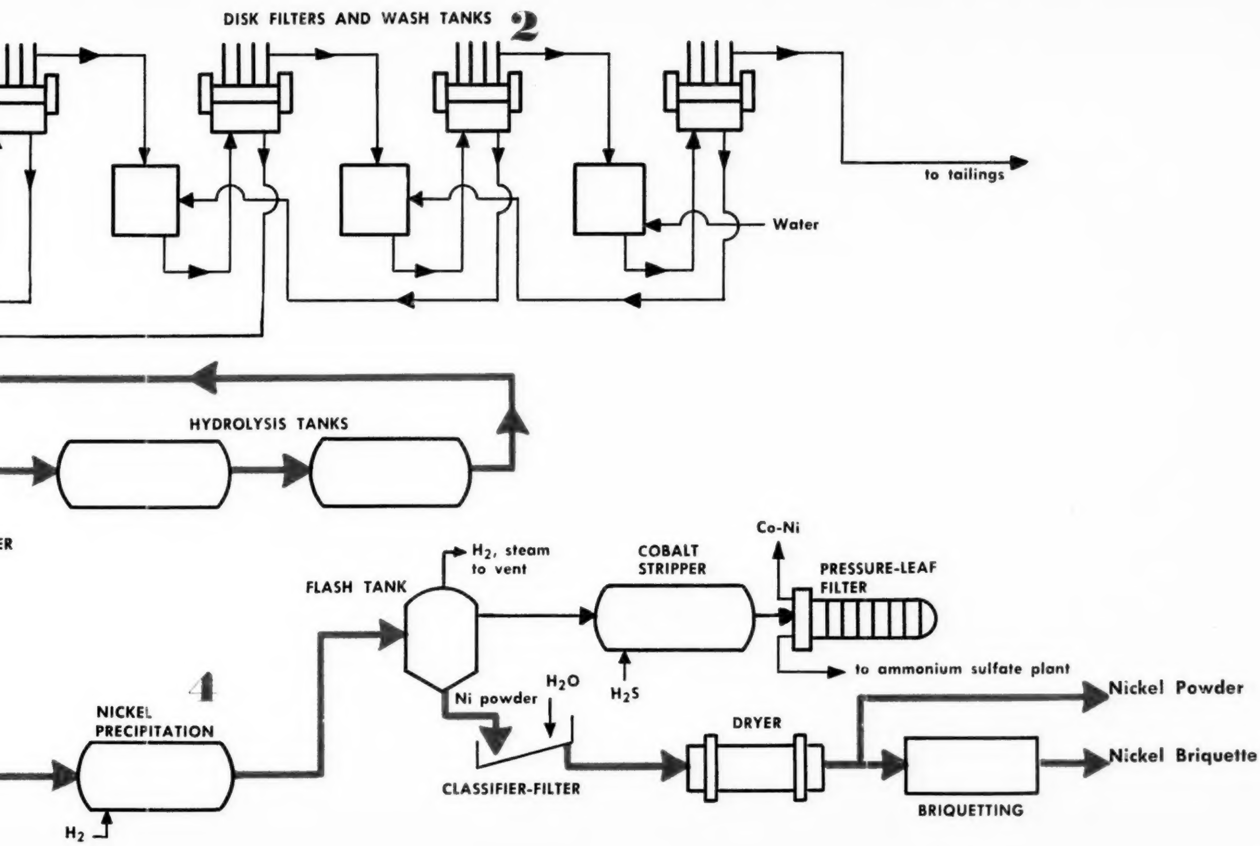
...CH: Air, ammonia convert concentrate to ...ulfate, unsaturated sulfur compounds.

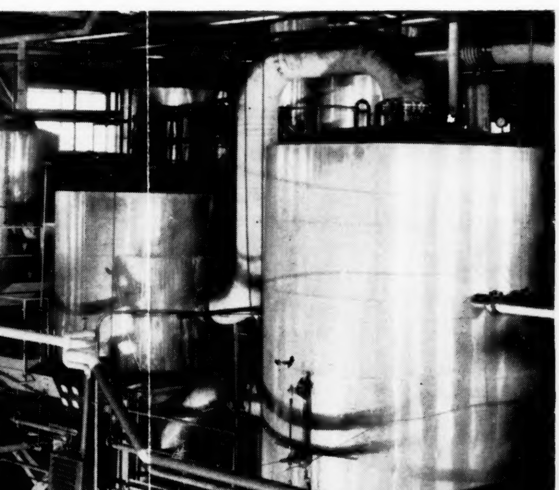


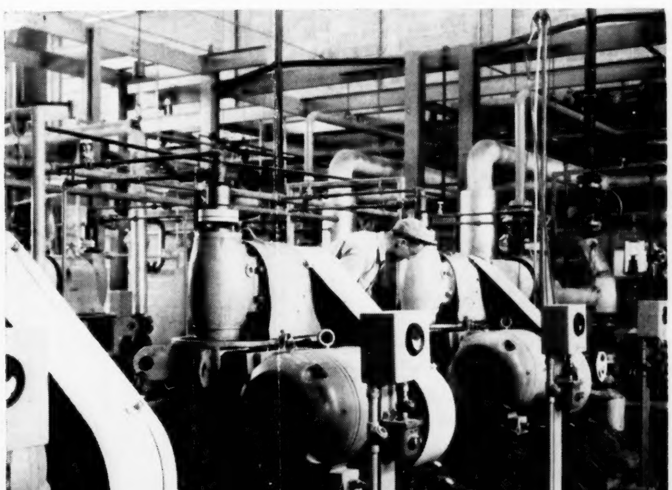
2 DISK VACUUM FILTERS separate tailings from leach solution. Filtrate carries the last traces of metal values.



3 COPPER REMOV... in these five still p...

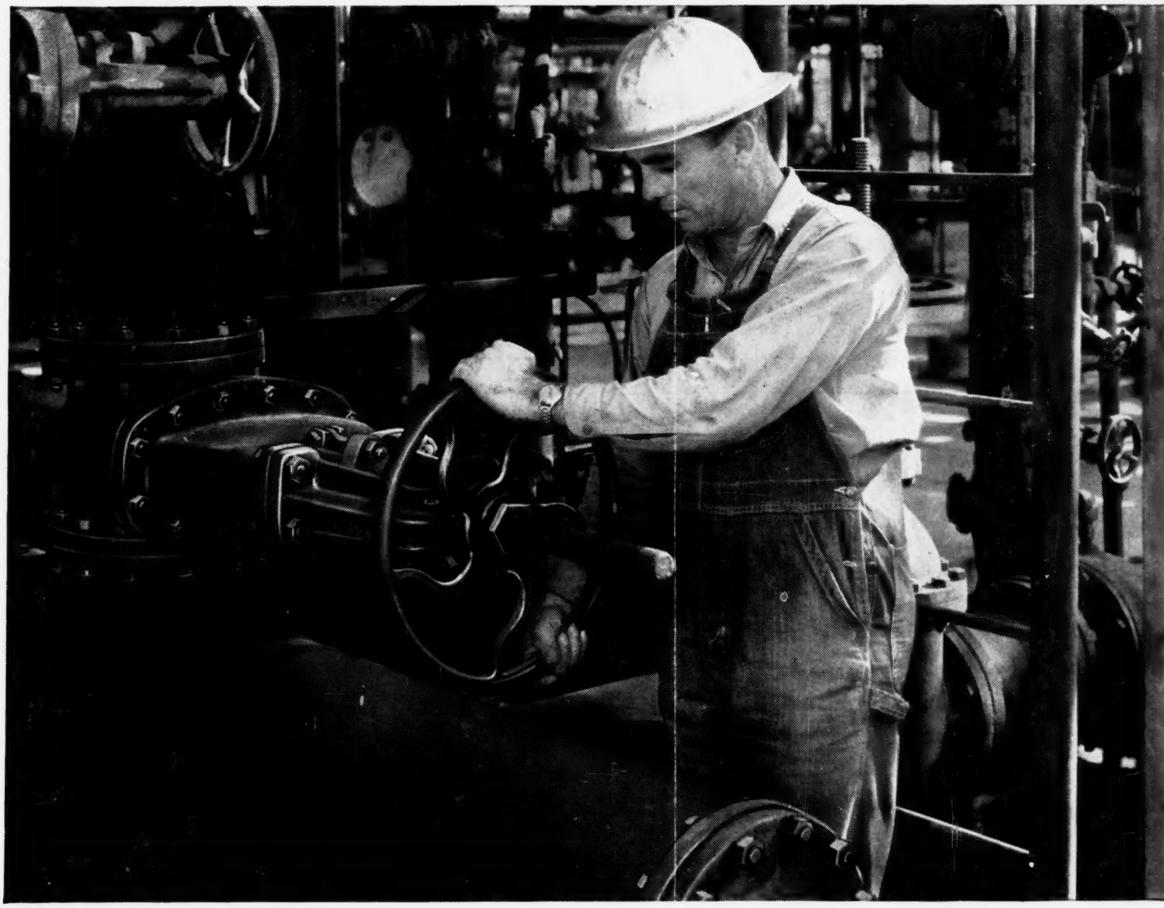






PER REMOVAL, by precipitation of copper sulfide, occurs
ese five still pots feeding vapor countercurrent to solution.

4 NICKEL PRECIPITATION, only batchwise step in otherwise continuous flow, stems from hydrogen reduction of nickel amine.



No leakage, no sticking with this Crane valve after 2 years on heavy alkylate at 300° F.

THE CASE HISTORY—How do Crane cast steel gate valves hold up on heavy alkylate? The No. 47X 10-inch, 150-pound valve you see above has been in service at Eastern States Petroleum Co. refinery at Houston for over two years.

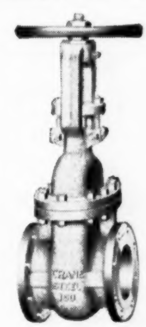
It handles re-run bottoms from the H_2SO_4 alkylation unit at 300° F. In addition to erosion from solid carbon, there is mild corrosion present from acid. Valve operation is on an average of once every 1½ weeks.

Not once has Eastern States had to put a wrench on this Crane valve. There has been no leakage, no sticking whatsoever. Closure is tight and sure, and response to the handwheel is as smooth and easy as the day the valve was installed.

Unusual performance? Not for Crane cast steel gate valves. For these valves differ from other valves on the *inside*—where performance stands or falls.

Over a century of skill is back of their sound design and pressure-tight castings, and in the heat treating and finishing of the Crane Exelloy seating. That's why Crane valves are *preferred* for refinery service.

Whatever you need in refinery valves—gates, globes, angles and checks—screwed, flanged or welding ends—sizes up to 24 in.—in pressure classes up to 2500 psi.—check with Crane first.



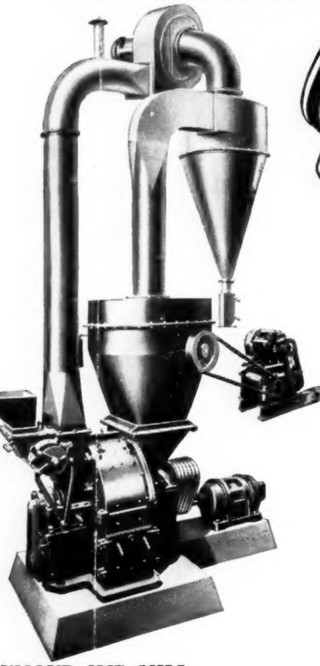
Call your local Crane Representative for valuable help in specifying and ordering, or write to address below.

CRANE VALVES & FITTINGS

PIPE • KITCHENS • PLUMBING • HEATING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

PRODUCING SUPERFINE *Intimate* MIXTURES



RAYMOND IMP MILL with Whizzer Air Separation. For medium capacities.

Compounding various powdered ingredients into a homogeneous intermixture for making a uniform quality product is an all-important process in the chemical, food, cosmetic and paint industries—for which Raymond Mills are preeminently fitted.

Raymond Roller Mills, Imp Mills and Screen Pulverizers have been used as standard equipment for years in blending operations on a wide range of materials. With suitable feeders for proportioning the ingredients to the mill, the finished product is delivered with a thorough dispersion of the particles, in the proper proportions, to specified fineness.

WRITE FOR BULLETINS

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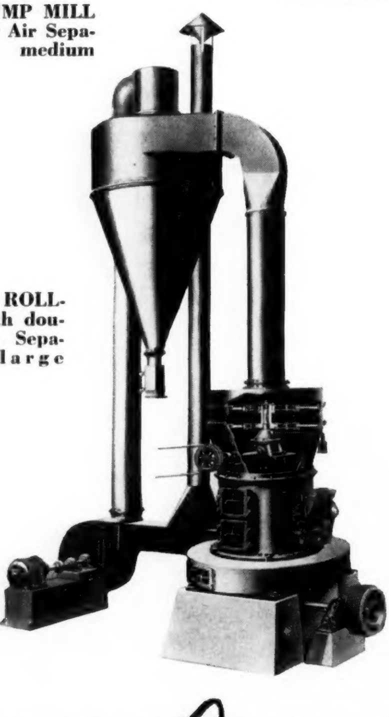

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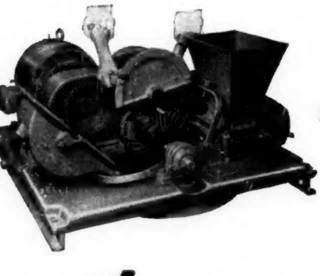

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JANUARY 1957

Department Index

CE takes another step forward in . . .

Serving the Whole Man

YOU'VE already noticed, without doubt, that there's "something different" about this issue of CE. You're right—there's plenty that's different.

Look closely for a minute or two at the contents pages just inside the front cover. There you'll see at once how we've reorganized all editorial into four broad sections: chemical engineering *developments*, chemical engineering *practice*, chemical engineering *people* and reader service. The first three of these are new.

DEVELOPMENT—In this first new section we report and interpret the month's most significant technical trends and developments: Processing, technology, plant expansions, chemical products, process equipment, chemical economics. This is the section you'll want to read first thing each month so as to keep up with the fast-moving world of chemical engineering progress.

PRACTICE—This section provides data on engineering techniques and know-how for engineers throughout the chemical process industries. This is the section to digest carefully, then to clip and save, for it is carefully tailored to give basic information that can be put to practical use by engineers in all job functions.

PEOPLE—Our third new section briefs the latest news about other chemical engineers, their jobs and companies, new books and their authors, CE's authors, what our readers are saying, You & Your Job. This is the section to read quickly and regularly so as to keep in touch with the living, growing world of chemical engineers and their jobs.

Each of these new sections has its own contents page, thus becomes a complete and independent editorial unit. We've also given several departments new titles that describe more accurately their broadened coverage and contents. And, of course, there are refinements in format and typography.

STILL another change—and a more profound one—will become increasingly evident during 1957: A broader coverage of trends and techniques of specific interest to chemical engineers in development and in equipment design.

This strengthened coverage of these two fields (which we've had under close study for over a year) will be integrated into our new editorial framework in the form of feature articles, feature reports, interpretive news, and departmental items. Tying in with these will be several new editorial series; five of these begin in the first three issues of 1957.

All these changes have been designed to make CE more logical, more readable, more usable, and more useful.

OUR aim in 1957: To serve "the whole engineer" wherever he is . . . in development, design, production, maintenance or in technical management.

John R. Callahan

INTRODUCING A NEW SERIES ON

Flow Through Packings and Beds

This article introduces a series which will bring those concerned with contacting equipment summaries of the principal contributions on flow through towers and reactors. Running about a year, it will emphasize the practical, but not neglect research and development interests.

MAX LEVA, Consulting Chemical Engineer, Pittsburgh, Pa.*

This series of papers of which this is the introductory and orienting article will deal with fluid flow through packed towers and granular-solids reactors. Problems that pertain to this broad field extend into virtually all process industries as well as the major chemical engineering unit operations.

Packed towers have been used for many years on a very wide scale in gas absorption, desorption, distillation and liquid-liquid contacting. In addition they have also found use in more specific areas, such as entrainment separators, and units for removal of industrial dusts, mists and odors. Finally it should also be mentioned that the old water cooling tower, except for the spray type, is always a packed tower, whatever its design may be.

Due to the relative simplicity of the packed tower, its design has so far not been standardized. Understandably, at least up to a few years ago, methods of design have also varied considerably. Unfortunately, it is also true that early research efforts, designed to obtain basic data for design, were at variance in a similar way. Consequently, a good many inconsistencies have become apparent.

Research activities pointed toward the establishment of design methods have, however, continued with increasing success, especially during the last two decades. In view of these developments and the positive results achieved, it seems desirable to summarize the major contributions.

How Series Is Organized

- Random packed towers
  - Gas-liquid systems
  - Liquid-liquid systems
- Stacked towers
  - Gas-liquid systems
- Reactors
  - Fixed bed
  - Moving bed
  - Fluidized bed

Design Considerations

At this point it must be made clear that the design of a packed tower is actually a threefold undertaking. First of all, there is the problem of analyzing the flow conditions through the tower. After a preliminary choice of packing has been made, the tower shell must be sized so that operational stability will be assured and the tower will function economically. This sizing of the tower must be aligned with the second and equally important problem of analyzing the proposed unit for its physical performance. This means determining its ability to bring about the desired change in composition in the involved streams. Finally, the third phase of the design is of a mechanical nature, involving the establishment of specifications for the auxiliaries, such as packing supports, liquid distributors and redistributors, if they are used.

Obviously, the aim of any optimum design is to bring these three aspects into harmony. How well this is achieved bears a direct relationship to the capability of the designer and his grasp of the individual problem components.

Primary concern of this series of papers will be to discuss details that pertain to the first phase of this three-pronged problem. To a lesser extent the series will also discuss characteristics of auxiliaries, so far as this is possible in a general way. The approach will be primarily practical but theoretical considerations also will be touched upon whenever there is reason to believe this will stimulate and promote thinking along research and development lines.

Flow through packed towers is a relatively complex problem. This is so because in most instances there is simultaneous flow of two fluids—usually in opposite flow directions.

Most frequently one of the fluids is a liquid and the other a gas or vapor as, for instance, in gas absorption or distillation. If both fluids are liquids, an obvious requirement is that they must be immiscible or, at least, only partly miscible in each other for the desired operating conditions of temperature and composition. This latter mode is of course characteristic of liquid-liquid contacting.

There are also instances where only a single phase is involved in the flow through packed towers. This occurs where packed towers are used for entrainment separation. The laws that govern single phase flow through packings are fairly well understood and working correlations of good quality are available to the engineer.

The history of packed towers is somewhat obscure, but not uninteresting. The earliest packed towers employed broken solids of many origins. Thus towers packed with pieces of coke were used for many decades, and still are in some isolated cases. As product specifications became more rigid, coke towers could no longer be tolerated.

*Meet your author on p. 294

Owing to the lack of homogeneous character of the coke, its poor physical properties and the lack of operational stability, coke was replaced as a tower packing by carefully shaped bodies of specific design and strength characteristics.

This marked the beginning of fabricated tower packings. Their history is extremely interesting as is brought out by an examination of the considerable literature in the form of patents and journal articles. However, despite the very great number of packings proposed, only a very small number of packings have become leaders and have found extensive use in the field. The main reason is that, in the development of a tower packing, it is not merely sufficient to consider characteristics of a definite shape and element. It is also required that this element can be manufactured readily and economically.

Requirements of a Packing

In the design of commercial packing units, the demand for flow resistance data is foremost in line. This is true for random dumped as well as stacked packings. Ability to predict the advent of the loading and flooding zone is next in importance. Here our data are much more complete for the random dumped packings than for the stacked packings. There are two reasons for this. First, towers carrying stacked packings are only infrequently operated at fluid rates sufficient to produce substantial loading or flooding. The second reason for the dearth of experimental flooding data on stacked packings is that large equipment is required to secure the data, and research funds are ordinarily not available for tests of such dimensions. Finally, hold-up data may be required. Here too the correlations pertaining to random-dumped packings are much more complete than for the stacked packings. As for liquid-liquid systems, the predominant question concerns the relative throughput of the two phases involved.

In line with the enumerated data needs, the first two or three papers *in the first part of this* series will deal with gas-liquid contacting in packed towers. The last paper of this first group will describe liquid-liquid correlations. The second group of papers will discuss flow through fixed, moving and fluidized beds. It must be understood that the phenomena of liquid-liquid systems have not been explored as thoroughly as gas-liquid phenomena. Accordingly, the correlations seem to be in greater doubt and less reliance can be placed on them than on their counterparts in the gas-liquid field.

Considerable advances have been made with gas-liquid systems. The prevailing and finally proposed correlations are chiefly empirical—but may nevertheless be used with great assurance for the solution of a wide range of problems. Thus the first three papers deal entirely with gas-liquid systems. The first two papers of the three will be confined to a consideration of randomly packed towers, whereas the last paper of the group will pertain to stacked packings.

Going on from the discussion of pressure drop, hold-up, loading and flooding, the articles will also consider column accessories, such as packing support plates, liquid distributors and redistributors. They will deal too with practical methods of charging towers, as well as operational features and characteristics of packings in particular. We shall also examine a few typical problems designed to demonstrate the use of the correlations.

In addition to packings in the usual sense, flow through granular solids beds is another problem that is widely met in the process industries and among the chemical engineering unit operations. Merely to indicate a few instances where granular solids beds are used, there are catalytic contact reactors; gas and liquid dehydrators using various solid absorbents; solvent recovery units packed with activated charcoal; ion exchange units; and a great many other types of apparatus.

Related also from a fundamental point of view are the problems pertaining to flow of oil or gas through sand strata, all questions of filtration, and other operations. However, these are far beyond the scope of the present series.

Flow through granular solids beds of the types discussed here *is a simpler phenomenon than flow* through packed towers. This is so because in granular solids beds there is usually flow of only a single phase to be considered. In the case of packed towers very definite packings have been developed over the years. However, special shapes of packings have not been proposed to the same extent for granular solids contactors. The use of irregularly shaped granular particles is quite widespread. Need for specific shapes for use in granular solids beds has not yet been recognized to the same extent as in packed towers.

Conflicting Data Reviewed

Flow through granular solids beds has received much attention during the past several decades. In view of the many conflicting results and the diversified approaches, there is a real need for reviewing this field and discussing the most widely used and best supported working correlations. We should also discuss theoretical aspects as far as necessary for research guidance.

Advances along fundamental lines have been considerable during the last 15 years. These were undoubtedly stimulated by the development and successful application of two newer contacting principles, fluidization and the moving bed. In line with this development, the second part of this series will first discuss flow through fixed-bed reactors. This will be followed by an exposition of flow through moving beds and fluidized systems. The articles will discuss major correlations used for predicting pressure drop and limiting flow rates in fixed and moving beds systems. Also covered will be operational aspects and problems pertaining to the control of fixed-bed, moving-bed and fluidized reactors.

Those articles of the series dealing with fluidization will go into somewhat more detail and present certain of the fundamentals to serve as a basis for the proposed working correlations. Working correlations for fluidized beds will relate to such matters as quality of fluidization, the prediction of the onset of *fluidization, limiting fluid* rates under which a fluidized bed *may exist, and prediction of the ex*tent of bed expansion. If time and *space permit, there may also be a* discussion of the related subjects of fines elutriation and heat and mass transfer.

Nine Graphs Speed Calculation of . . .

Water Demineralization Costs

Two-bed systems
Mixed-bed exchange
Single-bed, mixed-bed combination
Four-bed arrangement

F. H. KAHLER and A. C. REENTS, Illinois Water Treatment Co., Rockford, Ill.*

Chemical and engineering literature contains only meager data on ion exchange economics. Probably the most comprehensive study so far was that given by Monet.[1] Wirth[2] presented a paper on the expected life of strong base anion exchangers. His work, however, did not give a study of the economics of various deionization systems. McGill[3] gave an economic study of the operating cost for mixed-bed deionization. His paper did not cover other deionization methods.

The present paper is an attempt to provide operating cost information on all the ion exchange methods currently in use for the deionization of water. The data are applicable only to the conventional fixed-bed method of operation, with intermittent regeneration. Information on operating cost is presented graphically for waters containing dissolved salts in the range of 0 to 500 ppm., $CaCO_3$ equivalent. Correction factor curves for raw water variables (% monovalent ions and % weak acids of total ions) which directly affect operating costs are given for each deionization method.

Factors Affecting Costs

The operating cost figures most commonly reported with ion exchange equipment are only those required for regenerant chemicals, although it is well known that there are a number of other factors which affect the total cost for ion exchange treatment. Included in these other factors are the following: (1) water for regeneration; (2) power; (3) resin amortization; (4) labor; and (5) equipment amortization.

Of these factors, chemicals, water, power and resin amortization can be determined as a constant for all practical purposes for any given water supply and specific type of deionization system. The factors of labor and equipment amortization cannot be generalized. Labor costs will depend upon the frequency of regeneration, and this in turn is dependent on not only the analysis of the water supply, but also on the size of the ion exchange unit.

Obviously, the equipment amortization cost will be dependent on the water analysis, the frequency of regeneration, the flow rate required, and on such items as whether single equipment with storage, or duplex equipment, is used, and how complete the instrumentation is. Equipment amortization should be based upon the installed cost of the ion exchange system. Generally, ion exchange equipment is amortized over a 10-year period. This paper discusses only those variables which are relatively independent of the size of equipment and frequency of regeneration. The factors are: (1) cost of regenerant chemicals; (2) resin amortization; and (3) water and power for regeneration and operation.

Although these are relatively independent of equipment size, it is recognized that there are many factors that will affect these items in specific cases. The data shown must be very generalized. It is recognized that certain variations can, at times, effect a reduction in the total operating cost. However, the data shown are on a common basis, and are primarily intended to show relative costs for the various systems. Reclamation of portions of the regenerant solutions for re-use is not taken into account in this article.

This paper includes data on the following common deionization systems:

Exchanger Cycles Described

Two-Bed Systems

- Cation . . . Weak-base anion
- Cation . . . Weak-base anion with aeration
- Cation . . . Strong-base anion
- Cation . . . Strong-base anion with aeration

Mixed-Bed System

- Cation and anion resin in single exchanger

Mixed-Bed Combination System

- Cation with aeration followed by mixed-bed

Four-Bed System

- Cation . . . Weak-base anion, followed by cation . . . strong-base anion

Deionization Methods Covered

1. Cation-Weak Base Anion—The oldest method of deionization is cation exchange followed by a weak base anion exchanger. In this process the dissolved solids are converted to the corresponding acids in the cation exchanger. The mineral acids so formed are then removed in a separate unit by the anion exchange resin.

This method gives an effluent water containing carbon dioxide and silica in amounts equivalent to their respective contents in the raw

*F. H. Kahler is deceased. Meet author Reents on p. 295.

water. The carbon dioxide content can be reduced to a level of about 5 to 8 ppm. by aeration. The ionized solids content of the effluent water, irrespective of carbon dioxide and silica, is determined by leakage of monovalent cations through the cation exchanger. In general, monovalent cations, sodium and potassium, are the only cations which appear in the treated water. At the start of an operational cycle, the deionized water contains small amounts of NaOH and Na_2CO_3. As the cycle progresses, the effluent will contain $NaHCO_3$, and near the exhaustion point, NaCl. The order of appearance of ions in the effluent water from two-bed units is:

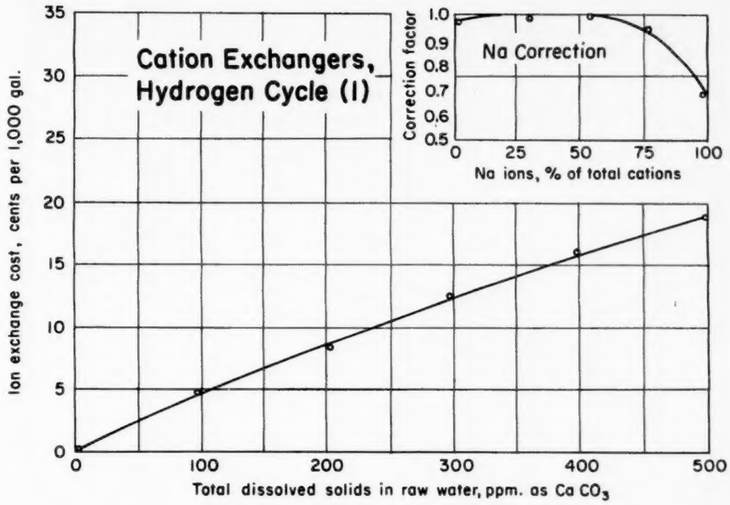
Cation Exchangers	Weak Base Anion Exchangers
Na^+	$HSiO_3^-$
K^+	HCO_3^-
Mg^{++}	Cl^-
Ca^{++}	NO_3^-
Fe^{+++}	$SO_4^=$

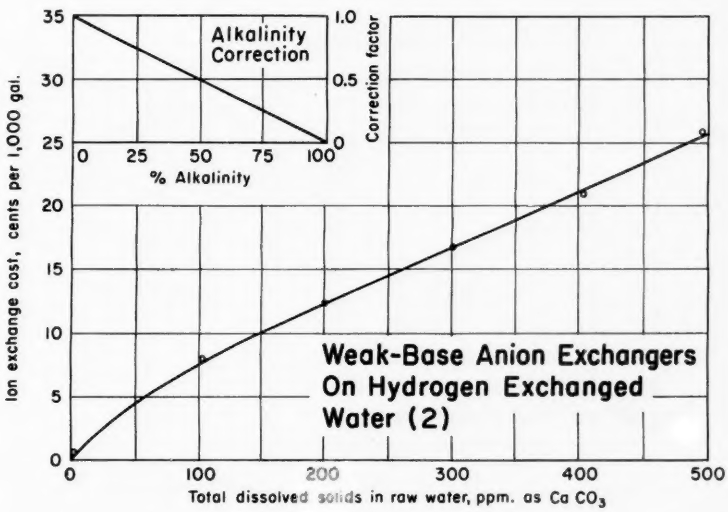
If the presence of carbon dioxide and silica is not objectionable, this is the type of water deionizer to use, as it is the most economical deionizing unit to purchase and operate.

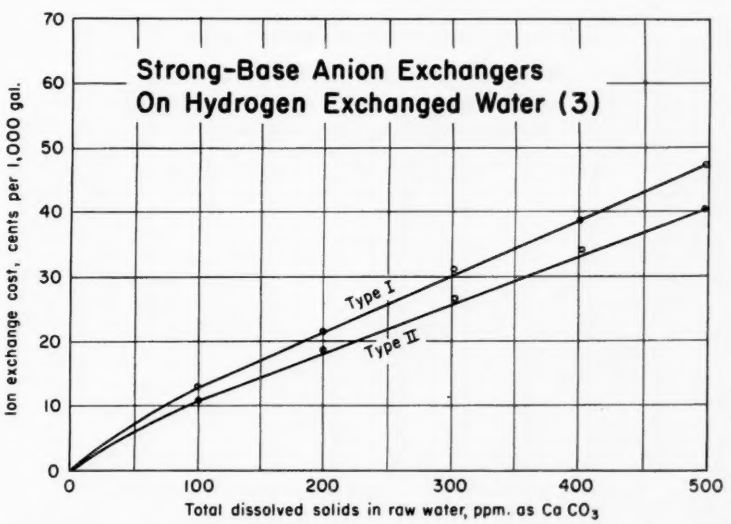
2. Cation-Weak Base Anion-Aeration—If the free carbon dioxide in the effluent from a two-bed weak-base deionizing unit is detrimental, approximately 95% of this CO_2 can be removed by passage of the water through a forced-draft decarbonator.

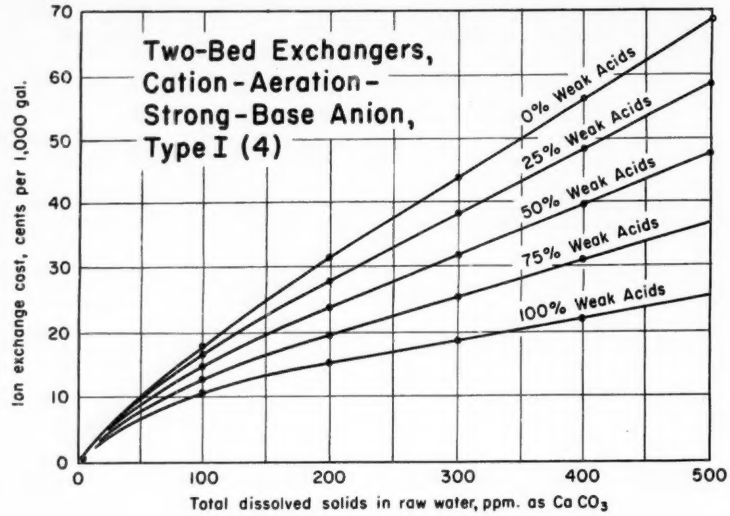
3. Cation-Strong Base Anion—When the strongly basic anion exchangers became available, the same basic principle of operation was applied. The quaternary types (strong base) anion exchangers removed not only the mineral acids, but also the weakly acidic materials, CO_2 and SiO_2. These slightly dissociated acids are exchanged as the HCO_3^- and $HSiO_3^-$ anions by the hydroxyl form of strong base anion exchanger.

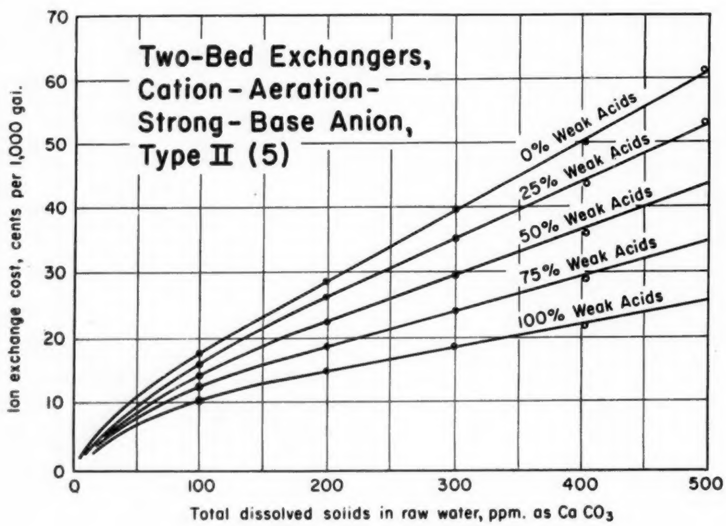
This type of deionizer contains a sulfonic type cation exchanger and a quaternary type anion exchanger. The effluent water is essentially free of ionized materials, with the exception of a small amount of sodium hydroxide. The sodium results from leakage through the cation exchanger, the hydroxyl ion from the anion exchanger. If water having a pH of 7.5 to 9.5 is satisfactory, this method of deionization produces an effluent containing small amounts of dissolved mineral mat-

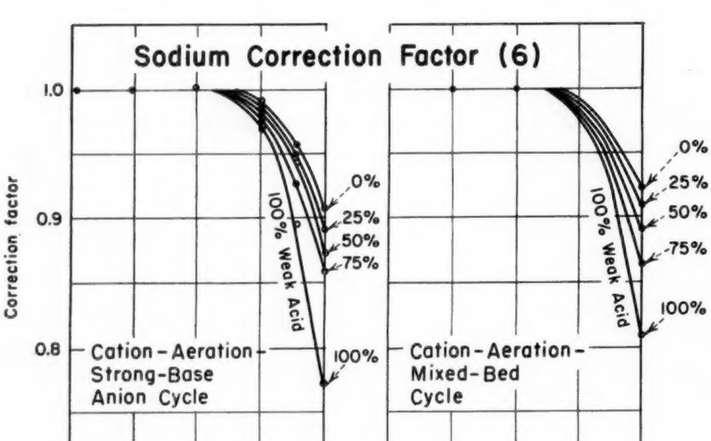












ter. Deionized water from such a unit, usually contains from 1 to 10 ppm. dissolved salts.

4. Cation-Aeration-Strong Base Anion—As the quaternary type anion resins remove weakly acidic materials like carbon dioxide, the addition of an aerator after cation exchange is common. The removal of carbon dioxide before anion exchange will decrease the load on the anion exchanger, thus reducing operating costs.

5. Mixed-Bed—It is known that repeated passage through cation and anion exchangers improves the final quality of water delivered. When both cation and anion exchange resins are intimately mixed in a single column, the effect is that of a very great number of passes through alternate cation and anion exchangers. Mixed-bed deionizing equipment is designed to carry out separation, regeneration, and remixing of the exchange materials in a single column.

The mixed-bed method of deioniztion produces an effluent water lower in dissolved mineral salts than any other process. The deionized water made by this method, using sulfonic type cation exchangers and strong base anion exchangers, contains from 0.1 to 1.0 ppm. dissolved ionized salts. If the process requires water of this quality, the use of the mixed-bed deionization method is merited and justifies the additional cost.

6. Cation-Aeration-Mixed-Bed—Since mixed-bed deionizers remove all dissolved ionized materials, economy of operation can be accomplished by pretreating by cation exchange, followed by aeration to remove the major part of the carbon dioxide. This decreases the load on the mixed-bed unit. Deaeration also makes possible longer operation of the mixed-bed resins before regeneration is required.

If the raw water to be deionized contains bicarbonate alkalinity or carbon dioxide in excess of 25% of total anions, the use of a cation exchanger followed by aeration for carbon dioxide removal ahead of the mixed bed is generally the most economical operation. This method gives a water of equivalent quality to mixed-bed operation, at a lower operating cost.

7. Cation-Weak Base Anion-Cation-Strong Base Anion—The so-called four-bed system has been used to produce deionized water of

lower salt content than can be made by a two-bed system. Although more economical chemical costs are possible with the four-bed system, increases in labor, water, and resin amortization costs generally offset this advantage. The method is best applied to waters of relatively high total dissolved solids—in excess of 300 ppm.

The advent of the mixed bed has led to the use of this type of unit after a two-bed deionizer. Rinse water requirements are much lower for the mixed bed than for the second two-bed unit.

On raw waters containing high percentages of alkalinity (HCO_3^-), a decarbonator may be justified between the two units of a four-bed deionization system.

Estimating Cost

As mentioned above, the costs for chemicals, water for regeneration, power, and resin amortization are essentially constants for any given water supply. These data are shown graphically in Figs. 1 through 9. An explanation of these graphs and their method of derivation follows:

Cost of Regenerant Chemicals—Table I

Cation Exchangers	Anion Exchangers
66° Bé. H_2SO_4, technical grade, at 1.5 cents per lb.	Sodium hydroxide, technical flake, 76% Na_2O, at 3.5 cents per lb.

All data shown on these graphs are based upon waters containing 0 to 500 ppm. total dissolved salts, $CaCO_3$ equivalent. The deionization costs are shown in cents per 1,000 gal. Regenerant chemicals and their assumed costs are shown in Table I.

Ion exchange resin amortization figures used to prepare the operating cost graphs include calculations

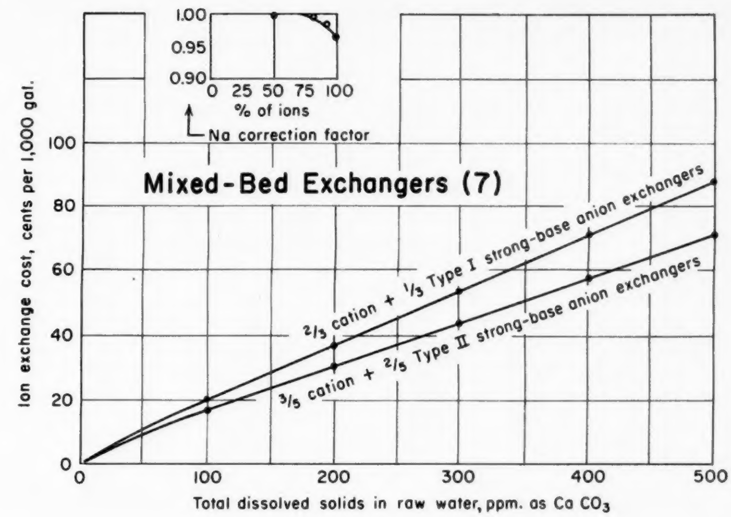
Costs of Resins and Utilities—Table II

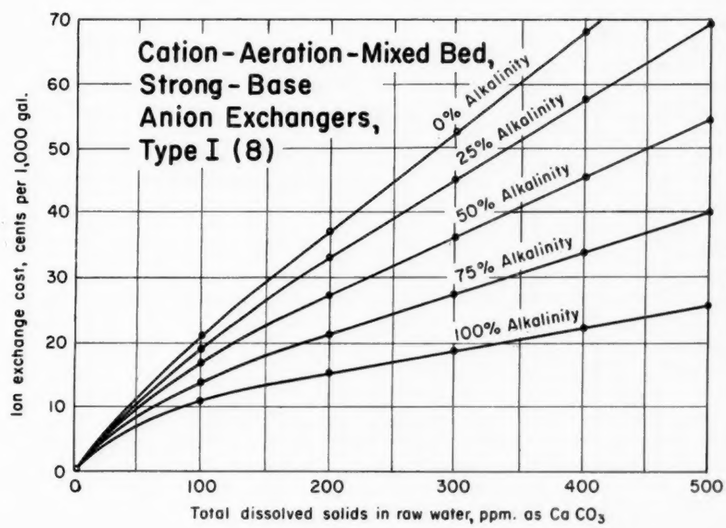
Cation exchange resin	$25 per cu. ft.
Weak base anion exchange resin	40 per cu. ft.
Strong base anion exchange resin	71.50 per cu. ft.
Raw water	0.10 per 1,000 gal.
Electric power for pumping and aeration	0.013 per 1,000 gal.

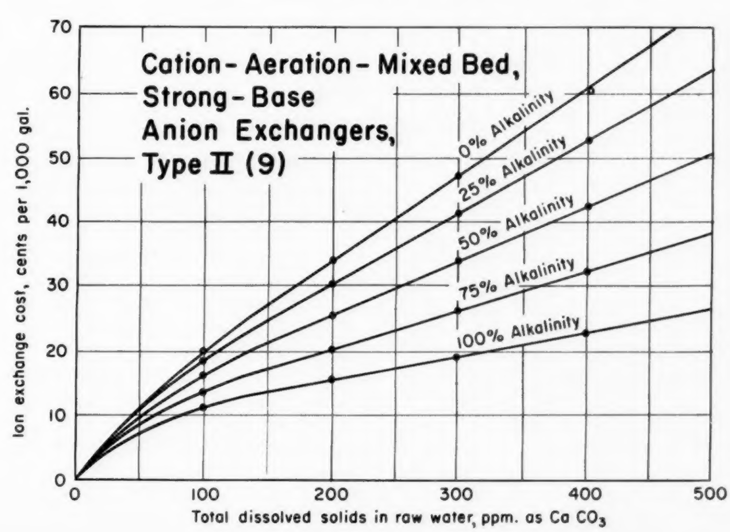
Chemicals for Regeneration—Table III

Resin*	Chemical	Regenerant Level, lb. per cu. ft.
Cation exchange	66° Bé. sulfuric acid	6.0
Weak base anion exchange	Sodium hydroxide, technical flake	3.5
Strong base anion exchange	Sodium hydroxide, technical flake	4.0

* Experience based on Illco resins.







Comparative costs for Various Deionizing Systems—Table V

Method	Cost, Cents per 1,000 Gal.	Deionized Water Quality, ppm. T.D.S.	SiO_2	CO_2
1. Cation-weak base anion	14.8	2.0	10.0	88.0
2. Cation-strong base anion, Type I	29.5	2.0	0.05	0.0
3. Cation-aeration-strong base anion, Type I	24.0	2.0	0.05	0.0
4. Mixed bed, Type I	38.0	0.1	0.01	0.0
5. Cation-aeration-mixed bed	27.0	0.1	0.01	0.0

for both a physical loss and a loss in ion exchange capacity. These figures are based upon laboratory and field operating data. Operating histories of the styrene-base cation and anion exchangers in various locations are available from 1948. Data for the weak-base exchangers of types comparable to those now in use date back to 1944.

The amortization figures given in Table IV are necessarily averages. The useful life of ion exchange resins for the deionization of water depends on a number of variables. Ion exchange resins, especially anion exchangers, are slowly degraded by the presence of oxidizing agents in waters. Among these are dissolved oxygen, nitrates, and chlorine. Turbidity over a few parts per million results in fouling of the resins. Surface waters containing organic materials[4] cause irreversible fouling of anion exchangers. In general, resins operated on clear well waters, low in oxidizing agents, will give longer useful life than is indicated for the ion exchange resins in Table IV. Conversely, waters high in turbidity, chlorine, oxygen, nitrate, and organic materials will degrade the resins more rapidly.

For accurate estimation of the cost of deionizing water by the various methods previously discussed, two important variables must be included. These are the variation in capacity of cation exchangers with variations in the ratio of monovalent ions (Na^+ and K^+) to total cations, and carbonate and bicarbonate alkalinity of the raw waters. As the percentage of sodium ions to total cations of the raw water increases, the exchange capacity of the cation exchanger increases. When waters containing bicarbonate alkalinity are hydrogen exchanged, the carbonic acid is decomposed, and the carbon dioxide can be removed by aeration. When aeration is used, the greater the percentage alkalinity of the raw water, the lower the ionized solids load on the anion exchanger. It was felt that the best way to represent these two variables was by the inclusion of correction factor curves on the cost graphs. To calculate costs, the base cost is determined, and this value is multiplied by the correction factor.

Resin Amortization Data—Table IV

Resin	Chemical Capacity* Loss	Physical Loss†
Cation exchange, sulfonic type	5.0	7
Strong base anion exchange, Type I. (active group—quaternary trimethylamine)	2.5	10
Strong base anion exchange, Type II. (active group—quaternary dimethylhydroxyethylamine)	2.0	10
Weak base anion exchange	1.0	10

* Useful life of resins, million gal./cu. ft.
† Percent of resins lost per million gal./cu. ft.

Total costs for cation exchange and weak base anion exchange are obtained from Figs. 1 and 2. To calculate costs, knowing the dissolved salts content of the raw water, expressed in parts per million of $CaCO_3$, read up to the total cost line and over to the cost figure. Multiply each value by the correction factor which is included in Figs. 1 and 2. When using the two-bed cation-weak base anion method, total cost is obtained by adding the corrected values obtained from Figs. 1 and 2.

Use Fig. 3 to get operating cost for strong base anion exchangers when treating water previously passed through a hydrogen-cycle cation exchanger. Data are presented for both Type I and Type II strong base anion exchangers.

Operating costs for the two-bed cation-strong base anion system are obtained from Figs. 1 and 3. Data are presented for deionizing systems containing either Type I or Type II strong base anion exchangers.

The cost data for the cation-aeration-Type I strong base anion exchanger are obtained from Fig. 4. The family of curves presented covers the full range of raw water-weak acid contents. Weak acid content is defined as the sum of free CO_2, bicarbonate and carbonate alkalinity, silica, sulfides and borates, if present. Similar information for the same system except for use of Type II anion exchange resins is given in Fig. 5.

Use Fig. 6 for sodium correction factors applicable to the systems: cation-aeration-strong base anion, and cation-aeration-mixed bed. Data shown include factors for various weak acid contents of the raw water. The base costs obtained in Figs. 4, 5, 8, and 9 should be multiplied by the proper sodium correction factor obtained from Fig. 6.

The cost of deionizing water by the mixed-bed method is given in Fig. 7. Cost curves are shown for both Types I and II strong base anion exchangers.

Operating costs as shown in Figs. 8 and 9 for the cation-aeration-mixed bed system, using Type I and Type II anion exchangers. Costs are calculated for this system in the same fashion as for the cation-aeration-strong base anion system (Figs. 4 and 5).

How to Use Charts

A typical example of the use of these curves in calculating deionization costs is of interest. Assume a raw water having a total dissolved solids content of 200 ppm. $CaCO_3$ equivalent, a bicarbonate alkalinity of 100 ppm., a sodium content of 40 ppm., and a silica content of 10 ppm. Then deionization costs for the various systems will be as presented in Table V.

The curves may also be used to determine operating costs for three-bed and four-bed systems. For example, to determine operating cost for the three-bed cation-weak base anion-strong base anion system, refer first to Figs. 1 and 2 to find operating cost for the cation-weak base anion system. Then determine the analysis of the water from this system. If aeration is used, add this cost to the operating cost. To this figure, add the cost of strong base anion exchange. This cost is obtained by referring to Fig. 3. The sum of these three costs is the operating cost per 1,000 gal.

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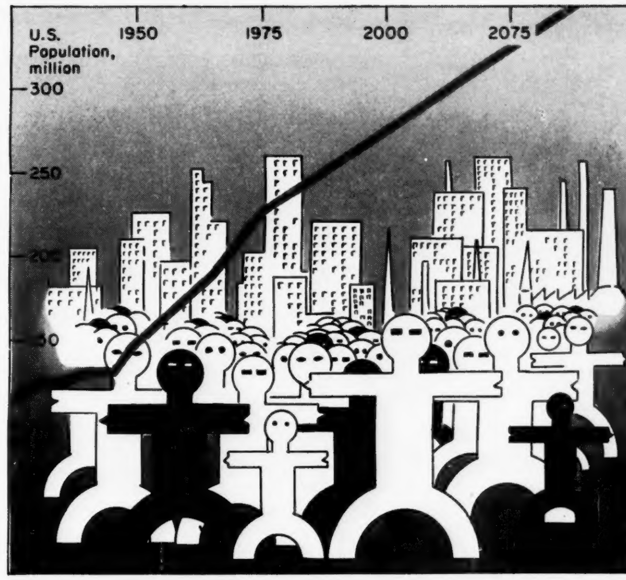
And Forecast



Population Boom Challenges Chemical Technology

Satisfying the needs of a fast-growing population, using natural resources steadily declining in quality and quantity, is a responsibility and a challenge to the chemical engineer.

In our annual Technology Review and Forecast a year ago our theme took the form of the question, "What's ahead in 1956?"

One answer to that question sets the stage for this year's review. For during 1956 nearly 3 million individuals were added to the U. S. population—equivalent to a new town of 60,000 in each of our 48 states.

Our population will grow by a similar number each year for the next ten years. Then the annual increment will turn sharply upwards when our "war babies" begin having children. By 1975 our population will have increased by nearly 40%; it may double before we're very far into the next century.

Our own growth rate will be exceeded in other parts of the world. World population is expected to leap from today's 2.7 billion to 6.7 billion within 100 years.

What does this population boom mean to the chemical engineer?

Each unit increase in population means one more mouth to feed; one more body to clothe, shelter and maintain in good health; one more mind to educate and entertain; one more citizen to govern and defend.

Quantitatively, these basic human needs are increasing faster than the growth in population itself. With advances in health and education throughout the world, standards of living are accelerating. Even with no population growth, today's trends in living standards mean ever-increasing demands for food and shelter, fuels and drugs, schools and newspapers.

Satisfying these basic human needs is both a responsibility and a challenge to the chemical engineer. Most of our natural resources are fast dwindling in quantity and/or quality. And geographical distribution of resources often bears little relationship to geographical distribution of population.

Even our manpower resources will be strained. Given enough energy, we can transport low-quality raw materials over any distance and process them into consumer products. Given sufficient incentive, we will develop this energy.

But in the last analysis, a richer life in a poorer world (as aptly expressed by B. Brewster Jennings, Socony Mobil's board chairman) will come only from greater productivity of the individual, be he farmer or miner, factory worker or chemical engineer.

We shall see in the next 15 pages how chemical technology is contributing to the enrichment of life in a world growing poorer in material wealth but richer in human resources.

Supply Man's Basic Needs

Man's basic physiological needs, as expressed by Richard L. Meier of the University of Chicago (*see p.* 289), are food and "protection from stress."

When individuals associate as groups, these basic needs expand to include education, work, government and recreation.

The per capita quantity of goods required to meet man's basic needs depends to a large extent on the standard of living of the individual or the group. For example, in the U. S. we consume fibers at a per capita rate of about 35 lb./yr. In Russia, even with its more severe climate, fiber consumption is only about 7 lb./yr.

Although per capita consumption in the U. S. of some products of farm and forest has reached a plateau (e.g., fibers), consumption of others will continue to grow or will change in pattern.

In the growth category is paper. Over the next 25 years per capita paper consumption is expected to jump from today's 400 lb./yr. to 1,000 lb./yr.

In the last category is food. Americans are increasing the proportions of meat, milk, eggs, fruit and vegetables in their diet, cutting down correspondingly on grain and other starchy foods. For the same per capita caloric intake, the changing pattern of consumption needs much more acreage.

These trends emphasize the fact that, of the four natural resources basic to life—sunlight, air, water and soil—the latter two even now cannot support our increasing population and rising living standards. In the years ahead man will be increasingly dependent on the help of modern chemical technology to satisfy his basic physiological needs.

Man-Made Polymers Enter New Era

Better understanding of catalysis mechanisms points the way to new techniques, new synthetic polymers, especially in the isotactic varieties of the polyolefins.

In the fields of clothing and shelter, the most outstanding contributions of chemical technology have been in the form of synthetic polymers.

Despite the tremendous progress since the pioneering work of Hyatt and Baekeland, many experts believe that man-made polymers are now at the threshold of a new era. Recent advances in polymerization technology and in methods of treating the polymers produced have developed entirely new materials and have extended the spectrum of usefulness of older products. Such advances will better equip man-made polymers to meet the growing needs of a growing population.

Research into the mechanisms of catalysis has brought about the new polymerization techniques. Headliners in this field have been the stereospecific, or "directed," polymerizations carried out by Italy's Giulio Natta.

Based to some degree on Karl Ziegler's now-famous work on low-pressure polymerization of ethylene in Germany, Natta's studies of a series of metal alkyl-metal halide complexes have resulted in the preparation of a number of isotactic polymers for uses in films, fibers and molded products. (In an "isotactic" polymer, monomer units are so oriented that each has the same steric configuration of asymmetrical carbon atoms. Its main characteristic is a high degree of crystallinity.)

Though Natta has made experimental quantities of isotactic polybutylene, polybutadiene and polystyrene, interest centers in polypropylene. More than 30 U. S. chemical makers are reported interested in licensing Natta's polypropylene techniques. In Italy, Montecatini will pilot the process on a scale of several tons per day. In West Germany, Bergwerkgesellschaft Hibernia is operating a 200-lb./day pilot plant.

Natta's work had hardly achieved prominence before other workers revealed that they, too, had made isotactics:

- Standard Oil (Ind.) uses molybdena-alumina catalysts, with metal hydrides as promoters, to make isotactic polymers, notably polypropylene.
- Phillips Petroleum—ever careful to call its low-pressure polymerization technique "a polyolefin," not just a polyethylene, process—revealed that its chromium oxide catalyst system has also made isotactic polymers.

With Phillips, however, copolymers of ethylene

and propylene, or a diolefin, receive much attention. Now about ready to leave the pilot plant, these copolymers may be commercialized soon.

While polypropylene, copolymers and such have been in the spotlight, polyethylene itself hasn't been neglected. Indiana Standard announced a new low-pressure process, which it has since licensed to Texas Eastman and Spencer Chemical. And many of Phillips' and Ziegler's licensees have made progress toward commercial operation.

The older, high-pressure polyethylene process has now been modified to enable it to make a high-density product with properties intermediate between normal high-pressure poly and the Phillips, Ziegler and Standard low-pressure polymers. This modification has been adopted by many U. S. and European producers.

Polyethylene (and other polymers) can also be modified by irradiation. Both General Electric and Sequoia Process Corp. has revealed methods for irradiating polyethylene to get a more rigid, more heat-resistant product. Developed principally to make better electrical insulations, the processes will also be adapted to produce heat- and solvent-resistant containers, piping and other items.

In Japan, researchers have applied an irradiation treatment to vinylon, a hot-water-soluble polyvinyl alcohol fiber, and to unplasticized polyvinyl chloride. Higher heat resistance and greater resistance to solvents resulted.

Researchers are using irradiation techniques with the whole range of polymer products. From these studies will come stronger, tougher, longer-lasting materials for structural uses, corrosion protection and a host of other applications.

Plastics Latch on to Building Boom

Use of synthetics by the construction industry will grow as architects and builders learn how to apply reinforced plastics as load-carrying members of structures.

Plastics have already established a firm foothold in the construction industry. Among their well known uses are a variety of nonstructural (non-load-carrying) applications—weatherproofing adhesives and decorative coverings, floor coverings (polyvinyl chloride), rigid and flexible piping (polyethylene, cellulose acetate, acetate butyrate), high-pressure laminates, illumination (transparent and translucent acrylics, polystyrene), foamed insulation (polystyrene and polyurethanes), moisture barriers (polyethylene film), structural sandwiches (corrugated fiber-reinforced polyester sheets).

But synthetic polymers, particularly the reinforced plastics, are destined to play an even greater role in our technology. For they may hold the answer to a problem with which we are faced—to provide more low-cost, high-standard dwelling units to accommodate our expanding population.

One approach to this problem—conceived by Monsanto Chemical Co. and to be executed by MIT's architecture department—is the "House of Tomorrow." In this house, reinforced plastics provide the load-carrying structure as well as the enclosure. Advantage is taken of plastics' moldability to get large curved shells capable of withstanding superimposed loads and providing necessary stiffness. (And, of course, plastics are also used in wall panels, flooring, illumination, etc.)

But other structures, employing entirely new construction techniques, may be in the offing. For example, changing economic conditions and new technical processes pose the problem of permanence in housing. Plastics can be used to provide readily demountable structures as well as economical, short-lived materials which could be periodically changed or renewed. Also, in such fields as desert and vacation housing, economical, quickly constructed units can be made of earth stabilized with synthetic resins. Another possibility is the use of plastics in providing necessary panels for solar-heated dwellings.

All these point to a bright future for plastics in construction.

Synthetic Fibers Free Marginal Lands

Displacement of animal and vegetable fibers by synthetics will release acreage which can be utilized to provide food and living space for our growing population.

To man-made fibers will fall the task of providing much of man's future clothing needs.

Increasing demands for living space and for foods will limit the amount of land available for low-profit crops. Wool is such a crop.

Wool has always been raised on marginal land and, as this land becomes scarce, wool will tend to become more and more of a luxury item. While no man-made fiber has the all-round properties of wool, synthetics can be more easily tailored to outperform wool in specific uses.

As a greater variety of such fibers are made and as new treatments which alter their properties are developed, this trend will intensify.

Among recent developments in the technology of man-made fibers are these:

- American Cyanamid announced its plans to bring Creslan, an acrylonitrile-based fiber, to the market place. A 27-million-lb./yr. plant will be built in the Pensacola, Fla., area by mid-1958.
- Tennessee Eastman has just gotten its Verel acrylic fiber into full-scale production at Kingsport, Tenn.
- Dow has decided to commercialize its new fiber, Zefran, with a plant at Lee Hall, Va. Dow's claims of dyeing ease have led observers to speculate that Zefran is a copolymer of acrylonitrile and vinyl pyrrolidone, or a terpolymer of acrylonitrile, vinyl pyrrolidone and a third compound, possibly methyl acrylate. Presence of vinyl pyrrolidone would account for high dye receptivity.
- In production on a semiworks basis, Goodrich Chemical's vinylidene cyanide-based Darlan is nonetheless going into commercial products, primarily women's fur-like coats.

New Processes Sweeten Sugar Yields

More sugar per ton of cane or beets is promise of technological improvements in continuous diffusion, purification via ion exchange, ion exclusion and adsorption.

As population expands and land is at a premium, the problem of food production—and maximum yield per acre of land—becomes more acute. In anticipation of this problem the sugar industry has been hard at work to develop new technology which will improve yields and lower costs of its product. As a result the last 18 months have seen one of the busiest periods in the history of sugar technology.

Two new processing techniques were introduced—one for cane sugar, the other for beet sugar. National Cylinder Gas's process for continuous diffusion of sugar cane was successfully demonstrated in a pilot plant at the mill of Fellsmere (Fla.) Sugar Producers Assn. Relying on a combination of osmosis and dialysis to do the job conventionally handled by the crushing and grinding action of a tandem mill train, NCG's operation promises higher efficiency (in sucrose yields, juice purity) at lower costs (installation, maintenance, labor, power).

For sugar-beet processors, University of Michigan engineers announced experimental results of a new "jet" process for extracting sucrose from beet pulp. Beet slices are entrained in a high-velocity jet of steam, and pulp is slammed against a baffle to rupture its cellular structure by a combination of mechanical impingement and internal explosion of cells. Advantages over the conventional batch diffusion process include 99% sugar recovery, simple equipment, continuous operation, high capacity and short holdup time.

In the refining end of the business, four processes share the limelight. After nine years of ironing out process kinks, Layton Sugar Co., Layton, Utah, reported first successful full-scale ion-exchange purification of both beet and cane sugar. Designed to replace both sulfur bleaching in beet-sugar refining and bone-char decolorization in cane-sugar refining, the new process stacks up favorably with the usual methods, offering lower costs, greater process flexibility, increased yields and higher purity.

But ion exchange, primarily a deashing procedure, may not completely supplant conventional refining techniques. With the successful substitution of activated granular carbon for bone char in 85% of the U. S. dextrose refining capacity, it seems likely that sucrose refiners may decide to investigate activated carbon's advantage—a 16-fold capacity increase, on a pound-for-pound basis.

Still another refining technique which sugar processors may turn to is that of ion exclusion, developed by Ultra-Sucro Co., New York, working with Illinois Water Treatment Co., Rockford, Ill. A modification of Dow Chemical's ion exclusion process, the new method makes use of the same type of resin bed used in ion exchange. But it differs from ion exchange by rejecting, not retaining, ions. High ionic concentration within the resin particles helps to remove crystallization-inhibiting materials from blackstrap molasses, thus allowing recovery of 7½ to 10% more crude sugar from a given amount of cane or beet molasses.

Another means to the same end is via electrodialysis through membranes, now getting a pilot-plant tryout by the Hawaiian sugar industry.

Pulp Processes Provide Flexibility

New advances in pulping technology and forest fertilization will help ease the pressure on pulpwood supplies caused by booming demands for more paper products.

Spurred by the promise that paper production and sales—already at a $10-billion/yr. high—will double by 1975, chemical engineers are taking steps to insure an equally expandable raw material supply.

Recent advances in technology have helped to broaden paper's raw material base, to make more efficient use of existing raw materials, to preserve and encourage tree growth, to utilize what was formerly wood waste.

Newsprint production—with a 19% capacity hike slated for North America—has received a good share of technical effort because of the urgency of its need to shift its raw material base. As a large-volume, low-cost product, newsprint has been particularly hard hit by dwindling supplies and rising costs of spruce and fir softwoods, which not long ago accounted for most of the wood used in all pulp and paper.

Because the bulk of U. S. commercial forests are in the East, where hardwoods now predominate, hardwood utilization is an obvious must to solve the newsprint and other shortages. Great Northern's chemigroundwood process, installed two years ago in East Millinocket, Me., made groundwood from hardwood logs possible for the first time. After subjecting hardwood logs to chemical pretreatment, conventional grinding turns out acceptable groundwood for newsprint furnish.

Improvements of greater significance are promised by a new groundwood-from-hardwood-chips process which is seeing its first commercial action in a new Gould Paper Co. plant in Lyons Falls, N. Y. By starting from chips instead of logs, it can utilize any chippable wood, soft or hard, much of which might otherwise go to waste. The new process harnesses conventional semichemical pulping equipment to groundwood pulping problems. Chemical pretreatment is needed with hardwood chips.

Under the heading of making more effective use of existing raw materials come such developments as: Crossett Co.'s new board-forming machine now in use at its Crossett, Ark., foodboard mill; two approaches to continuous cooking to produce high-quality pulp which are now gaining commercial toeholds.

The Crossett development opens the door to profitable use of low-grade hardwood by combining on one machine a variety of pulps whose strengths

and weaknesses can dovetail to produce a superior laminated paperboard. In the Arkansas plant a five-ply sheet is produced, possessing the strength of kraft and the imperviousness of hardwood.

The two new continuous cooking processes: The Kamyr process, a straightforward adaptation of batch digestion equipment to continuous pulping; horizontal multitube continuous digestion, which claims reduced cooking time, from 2-4 hr. to 35-60 min.

Action on the problems of replenishing and preserving forest resources has included: Pioneering fertilization of trees from aircraft, undertaken by Rutgers University on New Jersey forest preserves; application of fire-preventing chemicals from the air, practiced on a province-wide scale in British Columbia last summer.

Tests on forest fertilization indicate growth-rate increases of 40-65%. Practice is expected to reach full-scale proportions in another decade.

Attraction which quick-growing trees have for the paper industry is borne out by the fact that 60% of the coming three-year expansion program is scheduled for the South, whose pines are the most easily replenishable source of pulp supply.

Water Shortages Threaten Industry

Conservation is the watchword as engineers look for ways to reduce evaporation losses, lower process water requirements and reuse industrial and sewage effluents.

Thirteen plants in the Beaumont, Tex., area were saved at the eleventh hour from an enforced 56% cutback on water usage by heavy rains late in October. A water shortage of "unprecedented critical proportions" had led the Lower Neches Valley Authority to the brink of such drastic action.

While it took an unbelievably severe drought to bring this situation about, the Beaumont case may well be something of a forewarning for water users everywhere, droughts or no droughts.

Soaking up water in 1955 at the rate of 262 billion gpd., U. S. users will need 450 billion gpd. to slake their thirst in 1975. Industrial use will soar from 60 to 115 billion gpd., consumption for steam generation will jump from 60 to 130 billion gpd. and agricultural use will mount from 120 to 170 billion gpd. The chemical and allied products industries will need 50% more water in ten years.

Water's price tag has been rising with its rate of consumption, as richer supplies are exploited and competition with irrigation requirements intensifies. Average water cost for municipal systems decades ago was 10¢/1,000 gal. Now it's nearing 20¢. Some cities pay as much as 50¢. By 1970, or even 1965, costs may double again. (Average individual water bill climbed 19% between 1950 and 1953, to $10.25.)

Available supply sources and price aren't the only trouble spots. Local distribution bottlenecks are squeezing supply lines. A recent government survey of the nation's biggest public water-supply systems shows 58% to be adequate, 21% to be on the borderline and the rest to be inadequate. Thus 40% of the nation's cities are already to be shunned as places to locate, if water is important to a business. And 10% of the systems surveyed will be inadequate in ten years.

Should you try to circumvent this by bringing your water overland from a distance, you'll run into stiff transportation costs. Aqueducts, at $0.11/acre-ft./mi. (1 acre-ft. = about 300,000 gal.), and canals, at $0.02/acre-ft./mi., are fairly cheap. But if you resort—as most users must—to pipeline pumping, then figure on a tab of $3-7/acre-ft./mi.

Hugeness of the water-supply problem is manifest in estimates of capital investment required for public water facilities: Replacement value of present facilities is $23 billion. Add $17 billion for additional facilities in the next 20 years. Total investment to insure adequate facilities in 1975: $40 billion.

What can industry do, then, to save water? Here are some of the approaches being used:

- More and more plants develop their own sources of process and cooling water; cost is roughly half what they pay municipalities ($50-80/acre-ft.) for potable water.
- Engineers are revamping processes to require less water and are more stingily rationing water uses in present processes.
- Plants are using the same water more than once and are even bringing in outside waste water, such as sewage effluent (costing $6-10/acre-ft.).
- Experiments are under way on the use of molecule-thick films of cetyl alcohol on water surfaces to inhibit evaporation.
- By injecting fresh water, sewage effluent and industrial waste water into the ground, industry is replenishing ground water supplies and insuring them against sea water intrusion.

What Price Fresh Water From the Sea?

Although basically a simple operation, conversion of salt water to fresh—at low cost—has yet to be realized; while the problems are huge, so are the potential rewards.

Our best efforts at water conservation may be insufficient to cover long-range needs in water-short areas.

Conversion of brackish and salt waters is the great technological challenge of the future. Right now salt water conversion is too expensive ($100-1,000/acre-ft.), and conversion of brackish water is, at best, a marginal proposition. But the market for converted water is enormous.

Louis Koenig, of Southwest Research Institute, gives us a picture of how big it really is. Pilot studies of water-deficient regions in California and Texas indicate that, at a price of $40/acre-ft., an additional 11 million acre-ft. of water could be consumed and 10 million acre-ft. of present water usage displaced each year. That's an $800-million business.

If the market is big, the social and economic

effort required for mass water conversion is staggering. Koenig says that by the year 2000, south Texas alone will be able to use 12.3 million acre-ft. of water a year (in tonnage, about 40 times the nation's annual petroleum production, 400 times the chemical output). How many plants to convert this water? Fifteen thousand, each the size of the world's largest chemical plant!

Last year saw chemical engineers tackling the water-conversion problem with the full force of their versatile technology. And Congress voted an added \$¾-million appropriation for the Interior Dept.'s saline water research program, while Secretary Seaton set an optimistic 15-year-hence target date for commercial processes capable of taking drinking water from the seas, brackish inland rivers and lakes at a cost competitive with nature.

Conversion of saline water to fresh stands, theoretically, as one of the simplest chemical separations around. Yet to do it on a large scale at a reasonable cost becomes another matter entirely. While natural fresh water costs 5-30¢/1,000 gal. (depending on use and purity), largest successful water-making plants today—all following an evaporation process—barely can produce it under \$2/1,000 gal. (\$600/acre-ft.).

Key work in water-making last year searched out new cost-cutting tricks. Gaining momentum was development work on little-used processes that promise considerable economies. Chief among them were the membrane schemes (e.g., electrodialysis, osmotic cells), solar distillation, solvent extraction and refrigeration. Though none received large-scale tryouts to match evaporation or vapor-compression distillation, they seem to point in the direction where the water-shortage solution lies. Interior's program calls for their intensive study and definitely pins on this group its hope of making good on its target date.

Ionics, Inc., began pushing electrodialysis into small-scale commercialization for the demineralization of 1,000-6,000-ppm.-solids brackish water. The company feels that in this range electrodialysis has no real competitor, that it can produce water for less than 50¢/1,000 gal.

For the present, however, evaporation remains the most reliable big-scale water-making process, even if the most expensive. Last year saw plans completed for the two biggest installations of this type.

One, destined for Aruba, Netherlands West Indies, will produce 2.7 mgd. of drinking water from the Caribbean Sea, along with 12,500 kw. of electricity. It will consist of five six-effect, submerged-coil evaporator trains. Special feature will be a ferric chloride treatment for scale prevention. The other, destined for the Sheikdom of Kuwait on the Persian Gulf, will convert 2.5 mgd. of sea water to fresh in four towers of four flash evaporators each.

And pointing up the growing lack of fresh water supply in this country, Pacific Gas & Electric put its second train of triple-effect evaporators on stream to get fresh water from the Pacific Ocean. The water is needed for feed to steam boilers at PG&E's new power station at Morro Bay, Calif.

Pollution Problems Demand Attention

Population and industrial growth, shortage of water combine to make pollution control the top problem for engineers and management; the big question is one of costs.

Pollution is already contributing heavily to our water-supply problem, and in certain localities even "fresh" air is a disappearing natural resource. The problems are rapidly getting more acute; the more people, the more pollution, and the more any degree of pollution will prove obnoxious.

Pollution control is everybody's economic burden. The more pollution, the more every one of us will have to pay to control it. The burden will not grow lighter. It may prove staggering.

The Manufacturing Chemists' Association estimates that the chemical industry sets aside 2½ to 4¢ of its construction dollar for pollution-control equipment. Another survey assigns more than 5% of all industrial construction costs to air-pollution control measures alone, says industry has spent more than a billion dollars over the past five years for this purpose.

For an idea of water-pollution control costs look at a recent government forecast for spending for public sewerage facilities. It estimates that \$14.1 billion will be needed to increase facilities in the next 20 years (\$6 billion to plug present loopholes, \$8 billion to meet new population needs) plus \$8 billion to offset obsolescence along the way.

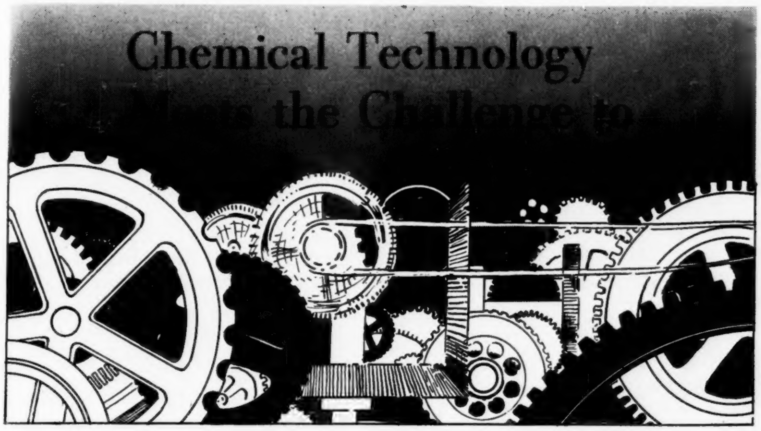
One way to ease pollution-control pains is to resort to more industry-municipality partnerships like the one set up between Carbide and Carbon Chemicals Co. and the City of South Charleston, W. Va. Aim of the joint venture: An all-purpose waste-treatment plant. The city handles the direct financing, the company supplies technical know-how and pays a share of operating, maintenance and financing costs. The company's wastes are diluted by the city's sanitary sewage, and vice-versa, a technical advantage.

In a two-pronged attack on one of the most refractory of all pollution problems—pickle liquor disposal—U. S. and British steel producers are piloting processes to combat pollution.

The Americans are experimenting with the Ruthner process—devised five years ago in Europe but not exploited—which calls for partial evaporation of pickle liquor, chlorination and separation of ferric chloride from sulfuric acid. The acid is degassed and the chloride roasted to give total chemical recovery.

The British crystallize ferrous sulfate from the liquor, roast it to the oxide and SO_2, passing the gas through an auto-oxidation tower which scrubs, compresses and catalyzes it to sulfuric acid.

Waste byproduct recovery isn't limited to heavy inorganics, however. The world's first plant to recover vitamin B_{12} from sewage sludge is going up at Milwaukee. For some time the city has been selling its sludge as fertilizer (Milorganite). Now the Alden Co. and Armour Labs are after the frosting on the cake, the B_{12} content, which will find a tidy outlet in animal feed.



Keep The Wheels Turning

Man's greatest use of energy today is to turn shafts. Although most of this shaft work is consumed by stationary machinery, in a mobile economy like ours some 20% of all energy is used to transport people and goods, and another 20% or so is used to make transportation equipment.

Energy and transportation are closely intertwined in another way. Fossil fuels, by far our predominant sources of energy, are unequally distributed over the earth's surface. According to one authority, two-fifths of all international shipping consists of the movement of fuels from country of production to country of consumption.

Man's energy needs, to a much greater extent than physiological needs, follow his standards of living. Again comparing U. S. with Russia (as we did earlier in regard to consumption of fibers), we find that our per capita consumption of all forms of energy is about 10 kw. every hour of the day and night, vs. 1.3 kw. in Russia. The figure for Pakistan is less than 0.03 kw.

Growth prospects for energy consumption are staggering. Even in the U. S. our energy consumption today is five times what it was in 1900. C. C. Furnas, Assistant Secretary of Defense, estimates that "a century from now the world will have bona fide need for some 50 times as much inanimate energy as it uses today."

When we realize that fossil fuels are essentially non-renewable, the urgency of stretching available energy supplies, as well as developing new sources, becomes apparent. In this field of endeavor lies, perhaps, today's greatest challenge to chemical technology.

Which Way to Higher Octanes?

New developments in catalytic reforming, isomerization and gasoline additives total up to more than 100-octane as super fuels reach the corner gas station.

In response to demands of our growing population for swifter, more efficient transportation, the aviation and automobile industries are rushing "hotter" power plants off their drawing boards and into their vehicles. High compression ratios, fuel injection, gas turbines, supersonic jets and rockets are the order of the day. It falls to the chemical engineer to provide fuels to power them.

Petroleum still offers our best source. Perhaps the most striking commercial milestone of 1956 was the appearance of 100-octane and higher gasolines at the filling stations of at least nine oil companies.

Catalytic reforming held sway as the most economic route to the super fuels. Though seemingly near an upper octane limit just a few years ago, cat reforming has spawned new versions to go still higher. Two processes announced in 1955—Houdry's Iso-Plus and Universal Oil Products' Rexforming—went commercial in 1956.

Two other processes, relying on more severe operating conditions over improved, continuously regenerated catalysts, also stepped firmly into the cat reforming picture. Esso's Powerforming, responsible for Golden Esso, embarked on a worldwide building program that will account for over 156,000 bbl./day by 1959. And Sinclair-Baker-Kellogg reforming added nearly 112,000 bbl./day capacity at ten new installations.

Upgrading with additives took a new commercial look during the past year. With tetraethyl lead already dispensed in doses as high (3 ml./gal.) as the law allows, refiners were turning to phosphorus-based chemicals and aromatics. Shell, already using tricresyl phosphate (TCP), added benzene, toluene and xylene to get Super Shell gasoline. And Sinclair debuted with secret Chemical "X." An alkyl phosphine, Chemical "X" piqued curiosity by reportedly lowering octane requirement of super engines rather than upgrading the fuel.

Aiming at boosting the yields of premium gasolines that can be catalytically cracked from crudes, Shell devised a two-stage cat cracker for its Anacortes, Wash., refinery last year. Crude and regenerated alumina-silica catalyst feed, as a moving bed, through a vertical pipe. Gasoline produced there is fractionated from gas oil, which then feeds to a fluid-bed reactor for a second stage of crack-

ing. Esso, thinking along similar lines, is developing a cat cracker incorporating some distillation plates. Heavy ends would thus drop back for a second cracking pass in the same reactor.

Interest in isomerization processes took a spurt last year when UOP's Penex, Atlantic Refining's Pentafining and Pure Oil's Isomerate were announced, and Phillips unwrapped its plans for early startup of an isomerization unit. Tailored to convert normal pentane, hexane and heptane fractions of refinery naphtha and natural gasoline to higher-octane isomers, these processes feed hydrogen and mixed paraffins over a fixed catalyst bed.

Chemical Fuels Power Rocket Engines

Supersonic aircraft and rockets demand fuels with higher energy content per unit weight than petroleum products; cost-reduction problems challenge chemical technology.

Although petroleum-based fuels will no doubt satisfy our growing demands for automobile propulsion for many years ahead, petroleum is apparently inadequate to meet the requirements of supersonic aircraft and rocket engines. Need for high-energy fuels is one of the most intriguing challenges to modern chemical technology.

Prodded by the crash ICBM program and by word that aircraft people were already thinking in terms of chemically powered bombers, chemical manufacturers last year headed rapidly into the high-energy-fuel business.

Predominant interest centered on a $74-million Navy and Air Force program. Olin Mathieson and Callery Chemical are prime contractors in this program. Metal Hydrides, American Potash, Pacific Coast Borax, Stauffer, Wyandotte, Thiokol, Hercules and several lithium producers are among the other companies involved in making high-energy fuels and their intermediates.

What is a "high-energy" fuel? Diborane, the simplest of the boranes (made by reacting an alkali-metal hydride with a boron halide), burns with a release of 1.5 times as many Btu./lb. as does gasoline. Penta- and decaboranes release even more energy per unit weight. Alkyl boranes, made by reacting diborane with a metal alkyl, are said to be more stable and easier to handle than the other boranes.

Other types of high-energy fuels are under study, too. A whole raft of chemicals, ranging from ammonia to plastics, have been investigated. Currently, much interest centers on the use of high-purity metal powders and such powerful oxidizers as elemental fluorine, halogen fluorides and perchloryl fluoride.

Costs of these chemical fuels are extremely high and, while volume production will bring some reduction, costs are expected to stay high. But work on new processes continues. For example:

- Stanford Research Institute is among those trying to develop a nonaqueous, electrochemical process for hydrazine, a widely used rocket fuel.
- Pennsalt has recently put into production a new process for perchloryl fluoride. It involves electrolysis of sodium perchlorate in a hydrogen fluoride atmosphere.
- Metal Hydrides has cut costs and hiked yields of the borane intermediate, potassium borohydride, by making sodium borohydride first and reacting it with potassium hydroxide.
- Stauffer uses a new fluid-bed technique to make boron trichloride.

Two new processes for making metal alkyls, useful both as intermediates for making alkyl boranes and as igniters in rocket engines, have been developed:

- Hercules is studying a German process that reacts aluminum directly with ethylene and hydrogen to make aluminum triethyl.
- Rocky Mountain Research makes aluminum trimethyl commercially by reducing aluminum with a methyl radical carrier (likely a halide), disproportionating the complex intermediates.

America Rides on Better Polymers

New and improved synthetics for making tires, seat cushions, insulation, even railroad cars and truck cabs, offer longer life, greater comfort and lower costs.

A galaxy of new technical developments in man-made polymers—rubbers and plastics—has been successfully aimed at making travel and transport cheaper, pleasanter, more efficient.

In synthetic rubber, the government's transfer of plants to private industry completed last year started fruits of industry research flowing from the laboratories—new rubbers, new applications, improvements on old ones.

Esso Research and Engineering has announced that it is commercially practical to make automobile tires entirely of synthetic rubber through use of a butyl latex which the company has perfected. This latex permits for the first time the bonding of butyl rubber with tire cord on existing plant equipment. According to Esso, the new all-butyl tire surpasses today's passenger car tires (75-85% styrene rubber, 15-25% natural) on such counts as resistance to cracking under chemical or atmospheric attack, ability to stop in 20-30% less distance, smoother riding, no squealing on turns.

Where butyl and styrene rubbers are weak—in resistance to the intense heat built up by truck tires carrying heavy loads over long distances—newly developed man-made "natural" rubber finds its forte. Firestone, Goodyear and Goodrich-Gulf have all synthesized polyisoprene products similar in structure and performance to natural rubber. Goodrich-Gulf and Firestone are producing pilot-plant quantities.

In a more specialized field, silicone rubber able to withstand temperatures from −170 to 600 F. is being tested by the rubber companies for jet plane tires, an upper-temperature use not suitable for present organic rubbers. Its ability to remain flexible at very low temperatures has enabled sili-

cone rubber to be used in many places where rubbery seals are needed on today's aircraft.

Urethane rubbers, such as Du Pont's Adiprene B (still in the experimental stage), show wear resistance twice that of first-line styrene rubber. What it will take to make the 100,000-mile-tread dream come true is the development of a suitable bonding agent for the tread. A practical tire could not be made entirely of polyurethane because of its high heat buildup.

Urethane and vinyl foams are beginning to nibble away at rubber foam's markets as insulating material for airplanes, trucks and railroad cars, crash padding for automobiles, seat padding. Though yearly sales are now only about 6 million lb., compared to total foam sales of over 230 million lb., urethane licensors Du Pont and Mobay predict 100-million-lb. sales by 1960, and vinyl licensor Elastomer Chemical foresees a 50-million-lb./yr. market. Optimism is based on such advantages as lower costs, higher resistance to fire, oil and chemicals.

Sponge rubber makers, however, are not just sitting back to watch. B. F. Goodrich has announced a "freeze agglomeration" process said to turn out an improved high-solids-content latex 2½ times as fast as conventional methods. It is expected to bring down cost of foam rubber latex.

Transportation industries are placing increasing demands on plastics because of such advantages as reduced weight and maintenance, abrasion resistance, high impact strength and toughness, ability to fill needs for transparent, colored or patterned surfaces.

Though for major components like body panels, plastics still cost more per pound than steel and are harder to fabricate: A line of reinforced plastic cabs for delivery trucks is now on the market; Budd Co. has brought out a new lightweight railroad passenger car with walls, ceilings and seats of polyester resin reinforced with glass fiber; U. S. Steel has developed a new vinyl-coated steel sheet for automotive bodies, now in experimental production, which may eliminate the need for protective or decorative finishing after fabrication.

Use of epoxy resin for dies, fixtures and other tools for making aircraft and automobiles is beginning to skyrocket. Bakelite, biggest producer of resins for tooling, has boosted its volume from zero three years ago to better than a 2-million-lb. annual clip today.

Solar Energy Intrigues Engineers

How can we put to work this inexhaustible source of energy at a competitive cost? That's the $64,000 challenge to chemical technology in the next decade.

Although its large-scale use—outside of agriculture—is a long way off in areas of the world where fossil fuels are still available in fairly generous supply, solar energy is attracting more and more attention. In 1956 it received what might be termed bona fide engineering recognition through formation of a solar energy applications committee by the American Society of Mechanical Engineers.

The present surge of interest dates from about 1950. In recent years many people have been studying the extent of fossil fuel reserves and attempting to project future energy demands. Whatever the reserves of coal, petroleum, oil shale, tar sands and natural gas may actually be, and whether future energy requirements actually grow at the almost exponential rate that is generally expected, it is clear that both nuclear and solar energy will eventually become essential.

There are four principal areas in which solar energy will most probably be used—heat, electrical and mechanical work, chemical processing and conducting biological reactions, such as the growing of food via photosynthesis.

Many potential solar energy applications suffer from the discontinuous nature of the radiation. In U. S. latitudes the rate of energy receipt during the midday hours is in the range of 0.65 to 0.90 kw./sq. yd. Most methods of utilizing solar energy are relatively inefficient at present, so it is obvious that not only must large collector areas be employed, but storage methods must be supplied to carry over the dark periods and cloudy days if the application of energy is to be continuous. Building heating and power supply are examples of usage where efficient storage methods will be essential.

Solar furnaces are already in use, mainly for research and materials testing, in many areas of the world. Small furnaces of 5-10-ft. reflector diameter are quite numerous. A 35-ft. unit is operating at Mont Louis in the Pyrenees, while the French government, in cooperation with industry, is building a 200-ft.-reflector furnace which will have an input capacity of about 1,000 kw. A 33-ft. unit in Algiers has been used to supply heat for a nitrogen fixation process. The U. S. Air Force is planning to build a 200-ft. furnace near Alamogordo, N. M.

Considerable effort is being directed toward the direct conversion of solar energy to electricity. Bell Laboratories' silicon-disk photocell, or "solar battery," now has an efficiency of about 11% but suffers from high cost. Other possibilities exist, such as the Air Force's cadmium sulfide cell. It has also been suggested that the introduction of improved thermocouple pairs may make it feasible to produce small quantities of electricity cheaply.

In the field of chemical processing, solar evaporation has been practiced on a small scale for many years in production of salt from sea water. Now that the drive is on to find new, low-cost ways of desalting sea water and brackish waters in fresh-water-short areas, solar distillation is being studied in a number of places. In southwestern U. S. it is possible to produce about 5,000 gal. of fresh water per acre per day. Although the energy is free, investment cost has been fairly high in solar stills built so far.

Agriculture, too, is expected to benefit from further research in solar energy utilization. Today's agricultural crops are only about 2% ef-

ficient as solar energy converters. Certain algae which are potential protein sources for animal feed can convert about 10% of the total solar energy to food values.

Many of the potentialities for solar energy will involve chemical engineers and chemical technology for their efficient development. Although large-scale applications may not be too close in time, certain specialized uses, particularly for favorable areas, are being developed even today.

Nuclear Energy Builds for the Future

By the time we achieve competitive nuclear power, possibly by 1965, we will have a solid engineering basis on which to build a full-fledged nuclear power industry.

Nuclear energy's engineering phase is now well under way. In 1950 engineers began their first tentative studies of the civilian aspects of nuclear power. By 1954, the year Congress revised and liberalized the original Atomic Energy Act, enough progress had been made to justify the pilot-plant study of nuclear power plants.

Since that date AEC has authorized seven experimental power reactors, along with several public and private utility plants. Several plants will be in operation by 1960, starting with the Westinghouse-Duquesne pressurized-water reactor at Shippingport, Pa., in 1957. By 1965 enough plants will be in operation and enough experience will have been accumulated to provide a good engineering base for future direction and for the estimation of capital and operating costs.

On the question of costs, skepticism is rampant today. Two years ago—even a year ago—every enthusiast was loaded with optimistic estimates. But conservatism is now in the driver's seat. Most people, however, expect that we will be on the track of competitive power from the atom by 1965. A few can see it even closer.

As things stand at present, there are three full-scale nuclear power plants under construction—at Shippingport (60,000 kw.), Monroe, Mich. (100,000 kw.) and Livermore, Calif. (5,000-10,000 kw.). In various stages of consideration are 12 other power reactors, ranging in size from 2,000 to 180,000 kw., all scheduled for completion by 1962 or earlier. When completed the 15 reactors will have a total rating of just under 1,000,000 kw., which represents a pretty small proportion of U. S. power capacity. However, there are those who maintain that by 1965 most central-station construction will have shifted from fuel-fired plants to nuclear plants. It is conceivable that by that time we shall also be getting some of our process heat from nuclear reactors.

There are innumerable problems that must be answered before the use of nuclear energy becomes the accepted order of things. Some may well be on the way to an early solution:

- Preliminary reports last year to the National Academy of Sciences have at least set the stage for solution of radiation safety problems. The reports gathered together what is known of the effect of radiation on living organisms and attempted to set up safe limits.
- The nuclear industry has now launched a program for the development of nuclear standards through American Standards Association.
- The insurance problem has now been formulated and, through government coordination of insurance activities and assistance with insurance coverage, is on the way to solution.

On the technical side, seven types of power reactors, including the latest types of the organic-moderated, liquid-metal-fueled and gas-cooled reactors, are to be tried out as part of the AEC demonstration program. Others are the pressurized-water, boiling-water, fast-breeder, aqueous-homogeneous and sodium-graphite types. All eight are among the 15 power reactors under construction or now planned. Another new type among the 15 is the sodium-cooled, heavy-water-moderated reactor. The British Calder Hall plutonium-power reactor, which recently went critical, is of the gas-cooled type recently added to our own program.

Thus many of the knotty problems of nuclear engineering are on the verge of solution via actual demonstration. Among these are the questions of what types of reactors hold most hope for the future. Problems of fuel production and reprocessing, which today are very vexing, may well be greatly simplified if the reactor choice should come down to one or more of the fluid-fuel types.

Chemicals Strengthen Coal's Position

Low-temperature carbonization, partial oxidation, upgrading of coke-oven gas and chemical byproducts mark coal's moves to offset inroads of oil and natural gas.

Recent chemical engineering developments and a favorable supply situation make it certain that coal, pushed out of traditional home heating and railroad markets by oil and gas, will not be so easily replaced in its largest and fastest-growing uses—as a source of industrial and public power and in the production of metallurgical coke and chemicals.

Unlike the limited reserves of petroleum and natural gas, U. S. coal reserves were placed at 1.9 trillion tons by the President's Materials Policy Commission in 1952. Only atomic resources can counter that kind of abundance. But atom-derived power can thus far be produced at coal's 6-mill/kwh. cost only on paper.

During the past two years an almost sudden resurgence of the coal industry raised production 20% in 1955, 17% in the first half of 1956. U. S. consumption in the electric utility industry alone is expected to go from about 150 million tons in 1956 to 300-400 million tons by 1975, even after allowing for developments in nuclear power.

Along with consumption increases has come a quickening in technological progress toward creating more applications for coal and making fullest use of it in existing applications. Such processes as low- and medium-temperature carbonization and partial

oxidation enhanced their commercial prospects during 1956.

To yield chemical bonuses from coal for the power market: The country's first commercial fluidized-bed, low-temperature coal carbonization plant was announced last year by Pittsburgh Consolidation Coal Co. To supply char to power part of Olin Revere's projected 180,000-ton/yr. aluminum plant, the Cresap, W. Va., carbonization plant will also derive liquids on which to base production of cresylic acids, cresols and phenols.

In medium-temperature carbonization (1,500 to 2,000 F.), there has also been commercial action. Char production (150 tons/day) will be emphasized in a plant under construction in Red Lodge, Mont., which will feed on western subbituminous coal and supply nearby lead, zinc and sponge iron smelters with a substitute for coke breeze, not locally available. Tar and creosote will also be produced.

In the field of conventional high-temperature carbonization, coke-oven operators are awakening to new possibilities in chemical technology. For several years coal chemicals have been losing ground in the growing aromatics market to the purer petroleum-derived benzene, toluene and xylene. Coal chemical producers are now taking steps to counter this competition with two of the oil processors' own refining techniques—hydrogenation and solvent extraction. Both Jones & Laughlin and U. S. Steel are readying plants to upgrade coke-oven aromatics.

The first U. S. synthetic ammonia plant based entirely on coke-oven gas has been started up by Ketona Chemical Co., and U. S. Steel is about to start up the second. Both are using low-temperature fractionation processes to get their pure hydrogen.

And more ammonia from coal is now available via partial oxidation at Olin Mathieson's new experimental unit at its Morgantown, W. Va., plant. It's the first commercial-size unit to employ the Texaco process for partial oxidation of solid fuel; it produces enough gas to make 80 tons/day of ammonia.

Metals Look to New Process Techniques

Growing demands for metals, old and new, plus longer hauls and leaner ores, spark the application of chemical technology to processes for beneficiation and reduction.

Transportation and energy have a solid stake in the technology of metals. Primary metal production is doubtless our largest use of nonmechanical energy. Huge quantities of ores are transported from remote sources of supply, especially as richer, more accessible deposits approach exhaustion. And developments in the "newer" metals are based largely on needs of the transportation and energy-producing industries, e.g., titanium and zirconium.

Take the aluminum industry, for instance. It's almost completely dependent upon imported low-silica bauxite for its source of alumina. Recent process developments have focused on the use of high-silica sources of alumina, such as anorthosite rock, various western clays and even wastes from the present Bayer alumina process.

Anorthosite rock is starting material for an alumina process developed by the Bureau of Mines. Lime-soda sintering is the key, and a recent, but undisclosed, technical advance is said to bring economical production near.

Anaconda is building a $1-million pilot plant to study a new process for alumina from domestic clays. It expects to get 10-14 tons of alumina from the 50-ton/day clay charge. This compares with the 25 tons of alumina that Bayer process plants get from 50 tons of high-grade bauxite.

Another aluminum producer, Reynolds, is reported to have taken an interest in a new electrothermic process for getting alumina and/or titanium dioxide from high-iron, siliceous ores, or even from Bayer process wastes. Developed by a subsidiary of Strategic Materials Corp., the new process is not yet in the pilot-plant stage.

Other Strategic Materials' processes have also generated interest. A recently completed pilot plant will process low-grade manganese ores to ferromanganese by electrothermal methods.

Successful development of new processes for fluid-bed reduction of iron ore could end the steel industry's dependence on deposits of coking coal and shift its emphasis to ores now difficult to handle in the blast furnace. Two of the newer processes, those of Hydrocarbon Research and U. S. Steel, use hydrogen to reduce the iron oxides. A process now in a pilot plant at Arthur D. Little uses methane, easily gotten in the natural-gas-rich Southwest or in countries like Venezuela or Iraq, where no steel industry now exists.

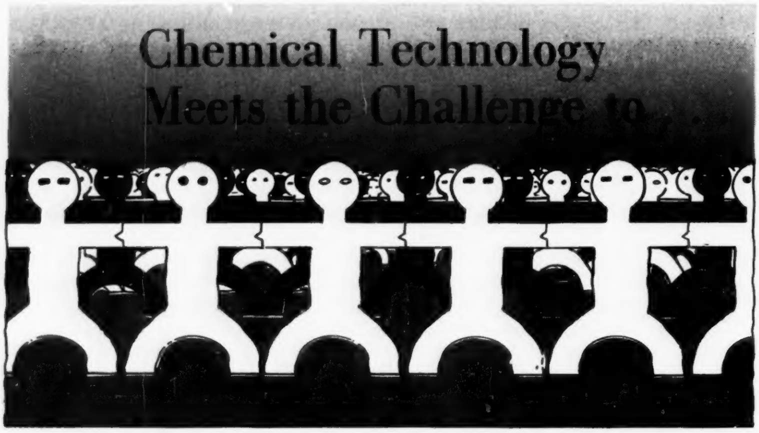
Titanium, zirconium, boron, lithium, thorium, uranium, beryllium, columbium, tantalum and other metals were available in only limited amounts a few years back. But the more severe operating conditions encountered in new methods of supplying energy, new modes of transportation and new processing developments have created demands that make their commercial production economical.

More and more producers are turning from the conventional magnesium reduction process for titanium and zirconium. Sodium reduction is getting a bigger play, and electrolytic processes are receiving much attention. The Bureau of Mines is working on a low-pressure sodium reduction process that skips the sponge step and makes titanium metal directly.

Liquid-liquid extraction has made great progress in metals technology, particularly in atomic energy work. Earlier work on metals separations primarily concerned ion exchange. Extraction technology has now begun to catch up.

Newer tantalum-columbium and rare earth-uranium separations rely heavily on liquid-liquid extraction. The recently revealed zirconium-hafnium separation also involves extraction.

Curiously enough, however, the newer uranium solvents—dodecyl phosphoric acid, di-(2-ethyl hexyl) phosphoric acid and several secondary amines—behave much like ion exchange resins—liquid ion exchange resins, if you will. Chemical equilibrium, not physical solution equilibrium, controls the pickup of solute by solvent. The uranium forms a chemical complex with the solvent molecules.



Stretch Our Manpower Resources

In view of the population boom we're experiencing, we might assume that manpower would be one resource which would be in plentiful supply. Won't we have a surplus of hands to man our farms and factories? Won't the youngsters now in the grade schools swell the ranks of the engineering profession a few years hence?

Careful study of available data point to conditions just the opposite of these assumptions. According to a study made by the Manufacturing Chemists' Association, the chemical industry alone will still be short some 93,000 scientists and engineers by 1975. And the total work force in the U. S. will be short an estimated 2 million people.

Explanation lies in the changing character of the population. With a booming birth rate, of course, the proportion of youngsters will be higher than today. And with a declining death rate (i.e., greater longevity), there will also be more oldsters. What with more young people spending more time in educational pursuits and workers retiring at earlier ages, growth of the total employment force will be relatively slow.

Another important trend is the reduction in the number of work hours per year as the result of a shorter work week and longer vacations.

It's apparent, then, that with population and living standards increasing at a much faster rate than available man-hours of labor, the chemical engineer will be under pressure to cut labor requirements per unit of output to the bone.

Greater technical efforts essential to getting maximum yield from low-quality raw materials at minimum expenditure of labor and energy will also delay for a long time any solution of the technical manpower shortage.

There are two, closely interrelated answers to this problem: Raise engineering salaries and boost engineering productivity. Raising salaries would no doubt add to the supply of technical manpower, but sound economics demands that increased pay be accompanied by increased output.

The chemical engineer's final challenge, then, is to pull himself up by his own bootstraps, mastering the latest time-saving engineering techniques and even inventing new ones.

New Devices Improve Process Control

Electronic instruments, working through electrically operated valves, are making inroads on pneumatic systems; end-point analysis, data processing show marked advances.

Process industries are continuing to move closer to the optimum in instrumentation, control and data handling. However, the movement is a gradual one, and what may be the optimum degree of automation in one industry may not necessarily be optimum in another. Thus it cannot be said that the inevitable end in every case will be the push-button plant. Full automation—what is often called "computer control"—will be difficult, if not impossible, to justify in many cases.

Since the war the instrument industry has increased tremendously. Older instruments are being modified and improved, of course, but one consequence of the industry's expansion is a rapid development of totally new ideas, most of which are electronic in nature. Transistors and magnetic amplifiers are beginning to take over from both vacuum tubes and electrochemical relays.

Electronic control is making inroads in the territory of pneumatic control, although the trend is slow to develop. One factor that has delayed acceptance of electronic control is the lack of electrical valves capable of competing costwise with pneumatically operated valves. The consequence is that the electronic process-control systems so far installed have used pneumatic valves as the final control element. But now the makers of valve operators are working hard to develop suitable electrical valves, and some claim they are close to beating the price problem.

Development continues in the field of end-point-analysis instruments, with the newcomer, gas chromatography, perhaps a future front runner among the new specific-type analyzers. Other new instruments of specific type which are developing more slowly are those based on nuclear magnetic resonance, paramagnetic resonance and microwave absorption.

Not all the development is taking place among specific-type analyzers. Older principles among the non-specific methods continue to be improved, while newer instruments, such as refractometers and dielectric-constant-based analyzers, are coming in for increasing attention.

Data-processing methods have been attracting much attention in the last two or three years. This development has grown up alongside the high-speed digital computer, and sometimes may be tied in with the computer, especially where plant information is to be "reduced," i.e., processed for accounting and management purposes. Here the fundamental idea is to "sample" all pertinent process measurements at sufficiently close intervals, convert the readings to digital form for read-out on tape or electric typewriters, and compare each reading with the norm for that particular point. If the reading is outside predetermined limits it sounds an alarm and may start a recorder which will then aid diagnosis of the upset by showing the trend.

Once the sampled data are in digital form they may be readily teletyped to distant points or supplied to a computer. Thus the new methods may lead to mechanized data-processing and a vast speed-up in the supply of information for accounting and for management decisions.

Computer control, which is gradually moving out of the talk stage and is actually being demonstrated in a few instances, may have moved several steps closer to actuality recently with the development of what seems to be a totally new concept. The usual approach is this: Assuming that we have several primary controls on a process and that some quality-measuring device shows that less-than-optimum results are being obtained, it is now up to the operator to reset the primary controls, as his experience indicates, to move the process in the desired direction. Substitution of a computer for the operator as a resetter of the primary controls would therefore optimize the process if the computer could be programmed as an actual mathematical model of the process.

Westinghouse has come up with the new idea, still in the experimental stage. The idea is to use what has been called an "automatic experimenter" —a computer which needs no knowledge of the process parameters, but only the ability to determine when a small experimental change in the primary variables has moved the process in the desired direction. Optimization is achieved by continual "experimenting" until the best settings for the current situation are reached.

Variable Speed Links Process Controls

Booming market for variable-speed drives reflects their importance in modern systems for controlling the application of mechanical energy to process machinery.

Where control is applied to a process through mechanical energy delivered as rotary motion, a variable-speed drive is the connecting link. Already we can see how demands for increased productivity are affecting use of this type of equipment.

During the past five years, sales of variable-speed drives have doubled; they are expected to double again in the five years ahead. One producer of d.c. drives reports that equipment produced during the past 15 years, in terms of horsepower, is twice the total produced during the firm's entire 60-year history prior to 1949.

New developments in variable-speed drives make them more accurate, dependable and responsive. Equipment costs less, is easier to maintain and occupies less space. Many changes relate to electronic control of the variable speed.

Direct-current drives seem to face real future growth because they fit so many automatic-processing requirements. In particular, they are considered preeminent where the duty cycle demands rapid acceleration, deceleration and reversing; also, where speed must be coordinated between different sections of the process. Through programming, d.c. drives can control operation of machinery and regulate production by feedback.

Production equipment controlled automatically with d.c. drives may prove more expensive than simpler equipment. Yet actual cost per unit produced may be lower due to higher output, better control of quality and product flexibility.

Radiographic Inspection Pays Its Way

Wider use of radiography enables industry to cut maintenance and first costs as well as avoid costly downtime; titanium is now moving rapidly into chemical equipment.

Undetected flaws in process vessels and lines need no longer rob industry of valuable production. There is now a big trend toward widespread radiographic inspection of equipment prior to final erection. Both X-ray and radioactive sources are used.

While safety has been the prime consideration, industry finds that it can reduce maintenance and first cost with radiography.

On pipelines, there's a rapid trend toward 100% radiographic inspection of sections traversing populated areas, highways, bridges and the like. Inspection used to be done on only about 10% of the line. But now pipeline people feel that the cost of complete inspection for these sections is far outweighed by assurance that the pipe will not need to be excavated at a later date.

There is even a move to check pipelines *in toto* for voids that might contribute to corrosion, leakage, contamination and explosions. And increasingly, engineers use portable equipment in the field on construction sites to check things like welds on field-erected oil storage tanks.

The mobility of modern radiography equipment is a major factor in its spreading use. With the wide choice of models now available, the user can work in and around equipment to get a complete inspection, unbarred by inaccessibility. Somewhat the same flexibility is obtained with portable radioactive sources. They can be positioned at the spot

to be radiographed, then operated remotely through a cable.

For visual inspection by fluoroscopy, equipment is available to detect flaws as small as 2% of total part thickness up to ½-in. thickness.

Among last year's developments in materials of construction, these are outstanding:

- Work-hardened stainless steel has been used extensively as a corrosion-resistant, high-strength material for room-temperature service. But investigators at Allegheny Ludlum have found that it does not lose its high-strength properties at high temperatures (1,350 F.).
- Titanium, some experts claim, is moving rapidly into chemical equipment. Decreasing prices, availability of many forms and maturing technology in titanium metallurgy are all spurring this trend.
- In the linings field, reinforced thermosetting plastics have been used for many years as linings. Now reinforced thermoplastic linings are in production. One new lining is a laminate of Kel-F. The plastic is fused onto a glass cloth backing. The manufacturer claims the lining can be installed in large tanks and vessels on the job.

Pump Standards Now Taking Shape

Standardization of dimensions and construction features of process pumps may lead to other equipment standards, with savings in technical manpower throughout industry.

New standardized equipment and practices are on the way to help meet mounting consumer demands on our production establishment. With increasing momentum, standardization programs are rolling forward to eliminate unnecessary duplication of engineering and scientific effort, reduce waste, increase efficiency and raise productivity.

There's evidence that companies are standardizing internally. At present, however, the limelight centers on industry-wide efforts under sponsorship of AIChE, MCA, the Hydraulic Institute and the American Standards Association.

What's encouraging is that the chemical industry and the chemical engineering profession now are throwing real weight toward this effort while our technology is still developing rapidly. Too often, standards have been adopted only after confusion and waste made them imperative. Today, in the atomic power program, we see for the first time how a new industrial technology can develop its standards as it grows, rather than later, when standards would be very difficult to develop.

MCA now has a Committee on Mechanical Equipment Standardization to determine where are the greatest potential savings from standardization, then to start projects that will help industry realize such savings. One such project, dealing with process pumps, is already launched by ASA Sectional Committee B-73 under cosponsorship of MCA and Hydraulics Institute. Others involving heat exchangers, tanks and fabrication of columns and towers are receiving preliminary study.

Committee B-73, which is developing the pump standardization program, consists of 35 representatives from manufacturers, users and general interest groups. Based on an extensive survey of these member groups, the committee set up at its meeting in October eight tentative pump ratings for which to develop dimensional standards. These ratings range from 25 gpm. at 50 ft. head and 3,500 rpm. to 1,000 gpm. at 250 ft. head and 1,750 rpm. In addition to dimensional standards, the committee aims eventually to standardize on desirable operating and maintenance features.

So far, no serious differences of opinion have arisen to hamper progress. While opinion is divided between choice of tangential or centerline location of discharge nozzles, tentative dimensional standards will be developed for each. A comprehensive survey conducted simultaneously will guide final choice.

Based on a limited survey, users prefer a pump design that provides for the impeller to be removed through the back cover plate. However, since either this design or a removable suction cover can be built within a standard dimension, final choice will be left to individual manufacturers.

Because of the fine cooperative spirit between user and manufacturing groups working on this program, prospects are excellent for ultimate success. And eventually both groups can expect to benefit appreciably.

When Will Ion Exchange Go Continuous?

Three more entries join the continuous-ion-exchange sweepstakes, while resin-in-pulp and ion exclusion processes chalk up advances in uranium and sugar technology.

Continuous processing, one of the chemical engineer's favorite tools for stretching labor supply, has not yet made the commercial grade in ion exchange. But, spurred by the huge potential still ahead for wider use of ion exchange in water treatment and hydrometallurgy, continuous techniques are pressing hard for a major breakthrough.

Three devices for accomplishing continuous ion exchange were openly suggested last year. Add to these other ideas evolving over the past few years and you have the makings of success in 1957.

First of 1956's triumvirate to be publicized was a column which moves the resin downward, a slug at a time, countercurrent to the liquid feed. Spent resin is discharged, and fresh resin admitted, in slugs. Pregnant liquor sweeps spent resin slugs from bottom of column to top of next tower in series. Du Pont is working towards the first commercial unit.

Another device, of Australian origin, employs a reciprocating diaphragm at the column's bottom to deliver pulsations to the resin bed. This action serves to "open" the bed and to permit movement of liquor up through the resin and out the top. Important advantages: Adaptation to fixed-bed ion exchange equipment is fairly simple; it can handle slurries with up to 40% solids contents.

Third proposal comes from University of Tennessee. A team there has put together a unit that calls for some pretty tricky pressure regulation but which is truly continuous (non-pulsing). In the upper zone of a column, regenerated resin contacts a strong feed solution admitted near the column's center and removed at top. Resin gradually falls down the column, through a central "isolation zone," and finally through a regeneration zone, where it is contacted by regenerant solution fed to bottom of column and taken off just below the isolation zone above. Regenerated resin drops to another isolation zone, is removed and returned to the top.

The Higgins "jerked-bed" ion exchange contactor continues to mature but is still in the pilot-plant stage. This unit lifts resin up through descending feed in a series of hydraulic surges. A 12-in. unit at Grand Junction, Colo., has worked well on uranium slurries recently.

A semicontinuous scheme, the so-called "resin-in-pulp" process, has found favor in several commercial plants. Screen-basketed resin is immersed, first in pulp containing the ions to be extracted, then in regenerant solution.

Ion exchange's offspring, ion exclusion, picked up its second trophy in two years. In 1955 it was glycerine purification for Lever Bros. Last year it was the Ultra-Sucro process, which promises the sugar producer 7-10% more crude sugar by removing crystallization-inhibiting materials from blackstrap molasses.

Planning Groups Operate at Top Level

Market research, cost engineering, economic evaluation staffs gain in stature as they help channel corporate efforts into the most profitable products and processes.

Conservation of human resources, like conservation of material resources, can be implemented by adequate planning. In today's economy, planning at the corporate level is taking on new dimensions.

Company planning (production scheduling, sales forecasting) isn't new, of course. But many new line and staff planning groups are being added to organization charts.

Economic forecasting, or profiling the general economy of the future, is growing as a staff function. The data collected is invaluable in charting financial policies, locating new plants and launching new projects.

Market research, as a staff function, has really come into its own recently. Groups in market research are concerned with determining the size and trends of specific markets, as well as looking into problems of distribution, customer preference and new product development.

Cost engineering is another up-and-coming staff planning function. Once devoted to the tabulation of cost data for cost estimation, this group now delves into questions of profitability: At what minimum scale of operation will a project break even? How will profit be affected by a delay in plant startup? How will it be affected by not operating at full capacity?

In June 1956 a group of cost engineers got together in Durham, N. H., to form the American Association of Cost Engineers. One significant trend showed up during the organization of AACE: Technically trained people are entering the planning field in increasing numbers. Probably as a result, some clarifying principles covering business planning are emerging.

One group of principles, now in a formative stage, is called "operations research"—the scientific approach to industrial problems which can be expressed in mathematical terms.

The chemical industry is getting more complex, with more vigorous competition and rapid changes in processes and products. It seems certain that more importance will be attached to the function of business planning—a new opportunity for chemical engineers.

Choose Your Own Reaction Environment

Activation energy for initiating a chemical reaction can come via divers routes; recent discoveries may open up the way to lower costs, higher yields or new processes.

This past year found chemical engineers looking long and hard at the environment in which commercial reactions can be carried out. Ultimate goals were lower costs, higher yields, getting reactions to go where they would not go before.

Under close study was the problem of how to supply the activation energy that kicks off the reaction. Energy can be supplied to a reaction mass in a variety of ways. Here are some of the more profitable 1956 solutions:

Gamma radiation—One typical case is the report from Esso research engineers that within their radiation cave in Linden, N. J., they have discovered certain chemical reactions which, under the influence of gamma radiation, are new and different.

Solar energy—Low-temperature and high-temperature application of solar energy to a reaction mass can be used to synthesize new chemicals.

Ultraviolet light—Most interesting 1956 application was physical, rather than chemical; ultraviolet light is being used to separate radioisotopes.

High temperatures—At the University of California-Stanford Research Institute high-temperature symposium last year, we learned that high temperatures not only open the way to new processes but also produce a fourth state of matter. In the 20,000-30,000-C. range, gases become thermal plasmas. In such a reaction environment—if we could produce it experimentally—a new world of chemical reactions opens before us.

Higher pressures—High-temperature conferees also discussed high pressures, announced that conversion of ammonia to metallic form by pressures over 200,000 atm. will soon become a reality.

Sonic energy—Physical chemists at Case Institute of Technology are investigating the effect of

sonic energy in the reaction environment. While most of their work has been more physical than chemical, the field of sonochemistry holds bright promise for future rewards.

High-frequency electrical discharge—According to Lord Mfg. Co., Erie, Pa., gas-phase reactions in a luminous high-frequency electrical discharge are now "commercially feasible." Most promising synthesis studied so far is the production of anhydrous hydrazine from ammonia.

Combustion reactions—Combustion as a field of science has been studied by many branches of engineering. However, combustion is a chemical reaction, and the more we learn about it as a reaction environment, the more we can gain from commercial combustion reactions. Reports to the Sixth International Symposium on Combustion at New Haven, Conn., indicated combustion processes can be used to synthesize hydrogen peroxide and nitric oxide with good yields.

But these new techniques don't detract from the importance of catalysts in getting the right reaction environment. In September over 700 scientists gathered in Philadelphia for the International Congress on Catalysis. Still a science of great secrecy, catalysis remains as the chemical engineer's most useful tool in providing the right reaction environment.

Whither Chemical Engineering Science?

Reorientation of chemical engineering knowledge along more fundamental lines would break down artificial, obsolescent concepts of unit operations and unit processes.

We can expect surging population to fall far short of our surging needs for scientists and engineers. Although population has increased about 30% from the 1930 census, our demand for engineers has increased about 150%, and our total need for scientists and engineers combined has increased about 335%.

Certainly the demand for engineering services is increasing with time at an exponential rate. Even with the World War II baby bulge coming along into our high schools, it would be unrealistic to imagine that population increase alone—or a push toward science and engineering careers by more students—will ever alleviate our scarcity of technologists.

The chemical engineer in 1957 will be thinking more along these lines. Our demand is not necessarily for scientists and engineers as persons; it is for the services that they can supply. If we can increase the output of today's engineers by 10%—or decrease their nonengineering work by 10%—it would have the same effect as immediately adding 75,000 engineers to our ranks.

Similarly, anything that the chemical engineer can do to use technical information more efficiently will be a step in the right direction.

Chemical engineers deal with the three states of matter—solids, liquids and gases. Problems of transporting matter certainly come within our technological jurisdiction. But our major concern is with bringing a solid, liquid or gas into contact with another solid, liquid or gas.

During contact (with or without energy transfer) we plan to produce a more valuable material than any of those we started with. Our next job is to separate this more valuable material from the less valuable materials in the contacting environment.

The study of the contacting environment, then, is the logical framework for the study of chemical engineering and the most efficient use of our chemical engineering science.

In 1956 many chemical engineers were coming to this very conclusion. Although "unit processes" and "unit operations" have served nobly in the development of chemical engineering as a separate branch of engineering, the trend is now in the opposite direction. We can no longer afford the luxury of having chemical engineers who are specialists in only a few of our 30 or so unit operations and 20 unit processes.

The trend is toward more generalization, but also toward more fundamentals. We will be looking for the fundamental similarities that underlie groups of unit operations. We'll recognize that unit processes just reflect differences in chemical reactions and are not really separate processes at all. The science of chemical engineering kinetics runs through all our unit processes, as does heat transfer, mass transfer, etc.

What gains can we hope for from this new framework of chemical engineering operations? The most important, of course, is more effective use of our engineering manpower. Other possible gains include:

- Development of more fundamentally sound theories for the operations of chemical engineering.
- A more practical concept of equilibrium.
- Use of a more realistic concept of driving forces, with pointwise design, rather than the use of over-all end-value driving forces.
- More uniform nomenclature for comparable operations.
- Exchange of data and technology among various industries that use contacting operations.
- Recognition of the fundamental capabilities that have been designed into commercial equipment to help it carry out similar contacting operations.

It will be our task, then, to find ways and means of using our knowledge more effectively. What of the future products of our booming population?

Perhaps, as Dean Elgin of Princeton suggests, we will no longer be able to afford even the luxury of training many different disciplines of engineering science. After all, engineers of all branches deal with three basic items—matter, energy and information.

Perhaps we'll never see it in our lifetime, but the three engineering branches of the future may be the matter engineer, the energy engineer and the information engineer.

"Far-fetched," you say.

No, not very. Our booming population and our exponentially increasing demand for technological service will demand it.

Banish Your Steam-Trap Troubles

How To: Choose
Size
Install
Maintain for top performance

L. C. CAMPBELL, Yarnall-Waring Co., Philadelphia, Pa.*

Your process and service steam traps are rather like the tail that wags the dog. They represent only a small fraction of total equipment investment, yet are the key to efficient operation of steam-heated equipment. That's why you should select and apply them with care.

Look around your own plant and see the wide number of different steam-trap applications. Among the operations that use steam traps you will note drying, cooking, evaporation, pulverization, fractionation, space heating, air conditioning and heat transfer, to mention a few. And you also may notice several different types of steam traps.

Purely on the basis of diverse applications and design, you face many points where possibly you may be able to improve operations and reduce cost. To help you improve performance of your heat processing equipment, we shall show you briefly what the steam trap actually does; how various commercial traps operate; how to select, install and maintain traps.

Why You Use Traps

We all know that a steam trap must remove condensate, air and noncondensable gases from equipment that uses steam. Here is why trap must do this job well.

During exchange of heat in steam-jacketed equipment, about 75% of the available heat in the steam is released. Steam condensed during exchange of heat must be removed as rapidly as possible. Otherwise, it insulates the surfaces, reducing heat exchange. And if condensate accumulates, it may produce water hammer which can blow gaskets, burst tubes, pipes and jackets.

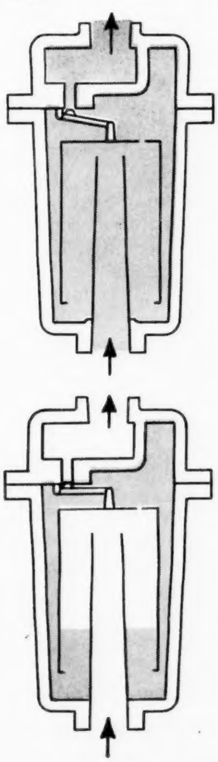
A trap that operates properly not only guards against such conditions but also returns a hotter condensate to the boiler.

When air and gas are in the steam, the temperature of the mixture is lower than that of the steam alone. Layers or pockets of air and gas on the surfaces reduce heat flow as much as does a layer of ground cork.

Types of Traps

Chemical plants use several different types of traps. Choice depends on the type of process and its temperature and pressure requirements, location of the trap, and other factors.

Inverted Bucket Trap



Lift or boiler-return traps discharge condensate at a pressure equal to or above the trap inlet pressure. Often, they are large, complex and costly. Applications are limited and few.

Non-return traps discharge condensate at a pressure below the original trap inlet pressure. These traps are by far the more common and the only type we shall discuss.

Float and Bucket Traps—This type of trap is built in a number of different shapes and designs. All have a float or bucket which opens an outlet valve after the trap fills with condensate. These traps handle condensate at high temperatures. Ability to handle air may be somewhat limited.

Probably, the most commonly used type of bucket trap is the inverted bucket type. It is much smaller than some of the earlier bucket designs. Most of the smaller models provide for straight-through piping which reduces the number of fittings needed for assembly.

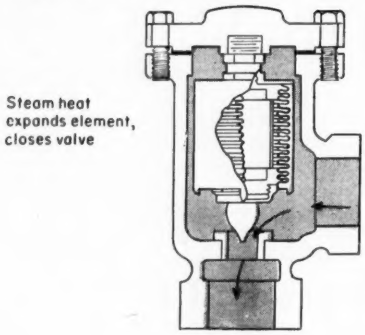
Inverted bucket traps eliminate air through a small vent in the top of the bucket. Differential pressure across this vent is small which limits the air flow. When large amounts of air and non-condensable gases must be vented, these traps are fitted with auxiliary thermostatic air vents.

Ball-float traps usually are used where you need continuous drainage and where relatively large size is not a detriment. A thermostatic element also may be provided to eliminate air and non-condensable gases.

Traps of this general type must be protected against freezing when used outdoors. Otherwise, the trap body may be broken.

*Meet your author on page 296.

Thermostatic trap



Thermostatic Traps—In this design, a bellows, with a valve disk on one end, is attached at the other end to the trap body. Hot steam entering the trap expands the bellows to move the disk against a valve seat and close the valve.

When the trap fills with condensate which cools below steam temperature, the bellows contracts opening the valve. Condensate then discharges until steam once again hits the bellows and closes the valve.

Alternate types of thermostatic elements used in these traps include expansion tubes and bimetallic strips.

Thermostatic traps, with their large valve orifices, can handle large amounts of cold condensate on cold startup. Near steam temperature, however, capacity is considerably less.

Since action of this trap is based on temperature difference, condensate must cool somewhat below steam temperature before the trap will open to discharge the condensate. When condensate enters the trap essentially at the steam temperature, it is desirable to supply several feet of cooling leg ahead of the trap. Then condensate is cooled sufficiently so that the trap will function properly to handle the load.

Because thermostatic devices, by their nature, require certain time intervals to respond to temperature change, trap action may be somewhat slower than other types. Ordinarily, thermostatic traps are not recommended for draining superheated lines.

Thermodynamic Traps—Oldest design in this group is the fixed-orifice trap which has a labyrinth passage and baffle to reduce steam flow. When hot water passes through the orifice, the drop from high to low pressure flashes some of the water to steam. This flashing tends to choke off the flow.

The hotter the condensate flowing through the orifice, the more choking results. Thus, the orifice valve can be adjusted to a balance point so that condensate discharges while live steam is held back.

If load fluctuates widely or pressure in the equipment changes, this trap may either blow steam or back up condensate. Therefore, it is most effective where load and pressure conditions are nearly constant.

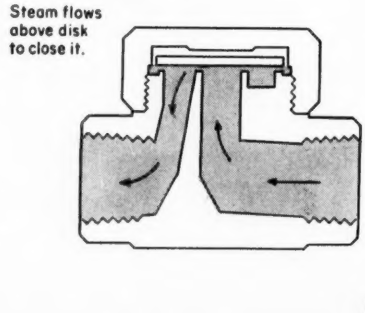
A widely used thermodynamic trap is the impulse type which opens wide on condensate but closes on steam. Hydraulic pressure on the trap pushes up a valve disk or piston to open the valve wide. Some condensate flows up past the disk into the control chamber, then out through a control orifice in the center of the valve.

When condensate approaches steam temperature a portion of it flashes to steam in both the control chamber and on the downstream side of the control orifice. This checks flow through the control orifice, raises pressure in the control chamber so that the valve snaps shut. Condensate then cools slightly till flashing stops so that the valve reopens to repeat the cycle.

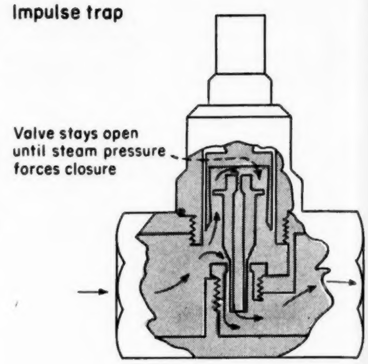
Traps of this type discharge condensate right up to steam temperature, yet close when steam reaches the valve. Initial heating of equipment is rapid and uniform. Control of condensate flow is extremely sensitive.

The impulse trap handles air very well. It is immune to freezing and can be installed either indoors or outdoors without special precautions.

Thermodynamic Trap



Impulse trap



Impulse traps may be used up to maximum pressure rating without changing valve or seat. The only adjustment needed is to remove a split washer on the control cylinder stem for pressures under 20 psig. These traps are built to operate up to 2,500 psi.

Special designs of the impulse trap include flanged and socket-weld integral-strainer units and a high-capacity trap for unusually heavy condensate loads.

Still another type of thermodynamic steam trap has an inlet orifice in the center over which is placed a circular flat valve disk. An outlet orifice is located off to one side.

When pressure acts on the trap, it pushes up the disk allowing the condensate to discharge. Steam entering the trap flows around the disk at high velocity to the chamber above the disk. Kinetic energy of the steam increases pressure above the disk, forcing it downward to close the inlet orifice. As the steam condenses in the chamber above the disk, downward pressure decreases so that the valve can reopen.

This action continues on a definite time cycle for a given set of pressure conditions. The trap may be used for 10-600 psi. without changing the valve or seat.

How to Choose Trap

It is extremely important that you choose a trap that will satisfy your plant or process operating conditions.

For batch processes, the best choice usually is a trap that can handle large amounts of air. Then each batch can be heated as rapidly

Use P Factors, P = (T-t)/L, to Find Condensate Load—Table I

Pressure, psig.	Temperature rise, F. 40	60	80	100	120	140	160	180	200
5	0.042	0.062	0.083	0.104	0.125	0.146	0.167	0.187	0.208
10	.042	.063	.084	.105	.126	.147	.168	.189	.211
15	.042	.064	.085	.106	.127	.148	.169	.191	.212
20	.043	.064	.085	.106	.128	.149	.170	.192	.213
25	.043	.064	.086	.107	.129	.150	.172	.193	.214
30	.043	.065	.086	.108	.129	.151	.172	.194	.215
35	.043	.065	.087	.108	.130	.152	.173	.195	.216
40	.044	.065	.087	.109	.130	.152	.174	.196	.218
50	.044	.066	.087	.110	.132	.154	.176	.198	.219
60	.044	.066	.088	.111	.133	.155	.177	.199	.221
75	.045	.067	.089	.112	.134	.156	.179	.201	.224
100	.045	.068	.091	.114	.136	.159	.182	.204	.227
125	.046	.069	.092	.115	.138	.162	.184	.207	.230
150	.047	.070	.093	.117	.140	.163	.187	.210	.234
175	.047	.071	.095	.118	.142	.165	.189	.213	.236
200	.048	.072	.096	.120	.144	.167	.191	.215	.239

as possible. Once the batch is up to temperature, the trap should handle the minimum load efficiently with maximum speed.

In continuous operations, ability to handle air is a secondary factor, though it is convenient to have for emergencies. Rather, efficient and fast removal of condensate at startup, normal and overload conditions is the prime consideration.

Consider standardizing on traps from one vendor. This may reduce both investment and maintenance costs, particularly if you use large numbers of traps.

Before you take such a step, however, check with your maintenance personnel. They have to keep the traps functioning and often have definite preferences for a particular type of trap. Good availability of traps and parts from a local source should also be considered before you choose a given make.

Engineers who are not familiar with sizing traps may choose a trap with the same nominal pipe size as the jacket or coil outlet. Traps chosen in this manner may be too large or too small. Oversizing may cause sluggishness or steam loss; undersizing may contribute to inefficient drainage of condensate and loss of production.

Trap capacity varies with condensate temperature as shown by any typical set of capacity curves for flow through a trap orifice. The exact variation that you can expect depends on the type of trap, its design and capacity.

An easy way to determine the relationships between size of trap body, pipe connections and capacity is to study the capacity tables published by various trap manufacturers. You will note that they tabulate or plot condensate handling capacities at various operating pressures.

To apply catalog data to specific problems, you must first calculate the condensate load. Then, you multiply this value by a safety factor specified by the manufacturer to obtain a figure which can be used with the trap capacity tabulation or plot to determine the required trap size.

How to Figure Load

The three distinct types of condensate loads to consider with steam-operated equipment are startup, normal and abnormal.

During startup, the apparatus usually is cold and full of air and other non-condensable gases. Because the cold metal must be brought up to temperature, condensate forms faster than normally. This causes a low pressure at the trap inlet and combined with the abnormal quantity of air imposes a heavy load on the trap.

Under normal operation, condensate may form at an essentially constant rate, or it may vary considerably. With a constant load, you can use a small factor of safety; if load varies you'll need a larger factor.

When used for heating pressure vessels such as autoclaves, retorts, sterilizers, etc., steam forms condensate by losing latent heat directly to solid material.

In the case of heat exchangers, cooking kettles, etc., steam gives up heat indirectly to a liquid through a metal surface submerged in the liquid.

Steam passing through radiators, unit heaters, chamber dryers, etc., forms condensate by giving up heat indirectly to air through bare pipe and tube walls.

On equipment such as paper dryers, platen presses, drum dryers, etc., heat passes from the steam indirectly to solid material through metallic heating surfaces.

Formulas for calculating condensate under each of these conditions are now set forth together with typical load problems. Four of the equations contain factor P. For convenience, this has been calculated and tabulated for various pressures and temperature-rise values, Table I.

For pressure vessels—$C = WSP$

Calculate the amount of condensate formed in a process retort when 2,000 lb. of a chemical with a specific heat of 1.0 is to be processed in 15 min. at 240 F. The insulated retort weighs 4,000 lb. Initial temperature is 60 F. and steam pressure is 25 psig.

For the chemical, $C = (2{,}000)(1.0)(0.193) = 386$ lb. of condensate. For the retort, $C = (4{,}000)(0.12)(0.193) = 93$ lb. of condensate. Total formed in 15 min. is 479 lb. which equals 1916 lb./hr. The safety factor allows for the radiation loss.

For submerged surfaces, known quantity of liquid—$C = G_wSP$

How much condensate forms in the jacket of a kettle when 500 gal. of water are heated in 30 min. from 72 to 212 F. with 50 psig. steam?

Nomenclature

- **C** — **Condensate load, lb./unit time**
- **W** — **Material heated, lb.**
- **S** — **Specific heat of material heated**
- **$T - t$** — **Temperature rise of material heated, deg. F.**
- **L** — **Latent heat of steam at trap pressure, Btu./lb.**
- **G** — **Liquid heated, gal./unit time**
- **w** — **Liquid weight, lb./gal.**
- **K** — **Over-all coefficient of heat transfer**
- **A** — **Heating surface area, sq. ft.**
- **H** — **Heat loss, Btu./sq. ft./deg. F./hr., see Table III**
- **t_1** — **Steam temperature at trap pressure, deg. F.**
- **F** — **Ambient air temperature, deg. F.**
- **R** — **Radiation from heating surface $\doteq H(t_1 - t_2)/L$, lb. condensate/hr./sq. ft., see Table II**
- **D** — **Material weight after drying, lb.**
- **P** — **An arbitrary factor = $(T - t)/L$, see Table I**

Condensate Formed by Radiation From Bare Iron and Steel, Lb./Sq. Ft./Hr.*—Table II

Air Temp, °F	Steam Pressure, Psig. 1	2	5	10	15	20	25	50	75	100	150	200	250	300	350	400	450	500	600
32	.53	.54	.57	.70	.74	.78	.81	1.02	1.13	1.30	1.46	1.70	1.86	1.97	2.31	2.41	2.52	2.62	3.14
50	.48	.49	.52	.56	.68	.71	.74	.87	1.06	1.15	1.38	1.52	1.74	1.85	1.96	2.06	2.41	2.52	2.71
60	.45	.46	.49	.53	.56	.59	.71	.84	1.02	1.10	1.34	1.47	1.58	1.80	1.91	2.00	2.35	2.46	2.65
65	.44	.45	.47	.52	.55	.58	.69	.82	1.00	1.08	1.32	1.45	1.56	1.77	1.88	1.97	2.07	2.43	2.62
70	.39	.40	.45	.50	.53	.56	.59	.80	0.98	1.06	1.21	1.43	1.54	1.75	1.86	1.95	2.04	2.39	2.59
75	.38	.39	.44	.49	.52	.55	.58	.77	.88	1.05	1.19	1.40	1.52	1.62	1.83	1.93	2.02	2.11	2.56
Value of heat loss used (H)	2.6				2.8			3.2		3.5			3.75			4.0			4.5 5.0

*Based on still air; for forced-air circulation multiply above values by 5

Condensate Formed in Submerged Steel Heating Elements, Lb./Sq. Ft./Hr.*—Table III

Mtd†	Btu./sq. ft/hr	Steam Pressure, Psig. 1	2	5	10	15	20	25	50	75	100	150	200	250	300	350	400	450	500	600
10	280	.28	.29	.29	.29	.30	.30	.30	.31	.31	.32	.33	.33	.34	.35	.35	.36	.37	.37	.38
20	930	.96	.97	.97	.98	.99	.99	1.00	1.02	1.04	1.05	1.08	1.11	1.14	1.16	1.18	1.20	1.22	1.24	1.28
30	1,900	1.96	1.97	1.98	1.99	2.01	2.02	2.03	2.08	2.12	2.16	2.22	2.27	2.32	2.36	2.41	2.45	2.49	2.53	2.61
40	3,100	3.20	3.21	3.23	3.26	3.28	3.30	3.32	3.40	3.46	3.52	3.62	3.72	3.78	3.85	3.92	3.99	4.06	4.13	4.25
50	4,500	4.65	4.66	4.68	4.73	4.76	4.78	4.82	4.93	5.02	5.11	5.25	5.38	5.48	5.58	5.69	5.80	5.89	5.99	6.17
60	6,250	6.45	6.47	6.51	6.57	6.62	6.65	6.69	6.86	6.97	7.10	7.30	7.47	7.62	7.76	7.92	8.06	8.18	8.33	8.58
70	8,000	8.26	8.29	8.33	8.41	8.46	8.52	8.57	8.77	8.93	9.08	9.34	9.56	9.75	9.94	10.15	10.32	10.47	10.65	10.97
80	10,400	10.73	10.77	10.83	10.93	11.00	11.06	11.13	11.40	11.61	11.80	12.14	12.43	12.67	12.92	13.17	13.40	13.62	13.85	14.26
90	12,500	12.90	12.95	13.00	13.13	13.23	13.30	13.37	13.70	13.95	14.20	14.60	14.94	15.24	15.53	15.83	16.13	16.36	16.65	17.15
100	15,000	15.47	15.55	15.62	15.75	15.86	15.95	16.05	16.44	16.75	17.03	17.50	17.90	18.28	18.63	18.97	19.34	19.64	19.97	20.57
125	22,400	23.10	23.20	23.30	23.53	23.70	23.85	23.95	24.55	25.10	25.45	26.15	26.75	27.30	27.80	28.35	28.90	29.30	29.85	30.73
150	30,000	30.95	31.10	31.20	31.50	31.70	31.90	32'10	32.90	33.50	34.10	35.20	35.85	36.60	37.30	38.00	38.70	39.30	39.95	41.15
175	40,000	41.30	41.50	41.65	42.00	42.30	42.60	42.80	43.80	44.30	45.40	46.70	47.80	48.75	49.70	50.65	51.60	52.40	53.30	54.85
200	50,000	51.60	51.80	52.10	52.50	52.85	53.20	53.50	54.80	55.80	56.75	58.30	59.70	60.90	62.10	63.30	64.50	65.50	66.60	68.60
250	82,000	83.70	85.00	85.30	86.20	86.70	87.25	87.75	90.00	91.60	93.10	95.70	98.00	100.00	102.00	103.70	105.70	107.30	109.30	112.50
300	100,000	103 30	103.60	104.00	105.00	105.70	106.30	107.00	109.50	111.60	113.50	116 60	119.40	122.00	124.20	126.50	128.80	131.00	133.30	137.00

*For copper, multiply table data by 2.0 For brass, multiply table data by 1.6 †Mean temperature difference, F = temperature of steam minus average liquid temperature
Heat transfer data for calculating this table obtained from and used by permission of the American Radiator & Standard Sanitary Corp.

External Area of Standard Pipe, Sq. Ft./Ft.—Table VI

Pipe Size, In.	Area, Sq. Ft.	Pipe Size, In.	Area, Sq. Ft.
1/2	0.22	4	1.2
3/4	0.28	6	1.7
1	0.34	8	2.3
1 1/4	0.44	10	2.8
1 1/2	0.50	12	3.3
2	0.62	14	3.9
2 1/2	0.75	16	4.5
3	0.92	18	5.0

$C = (500)(8.3)(1.0)(0.154) =$ 639 lb./30 min. or 1,278 lb./hr.

For submerged surfaces, unknown quantity of liquid—$C = KAP$

How much condensate forms in a 40-sq.-ft. coil submerged in an oil-heating tank if the oil is heated in minimum time from 60 to 200 F. by 25 psig. steam?

$C = (100)(40)(0.150) = 600$ lb./hr.

For pipe coils in air—$C = AR$

Calculate the amount of condensate formed in 500 ft. of 2-in. pipe used to heat a chemical storage warehouse when the steam pressure is 15 psig. and the air temperature is 60 F.

$C = (500)(0.62)(0.56) = 174$ lb./hr.

For dryers—$C = 970(W - D)/ + WP$

How much condensate is formed in a chamber dryer when 1,000 lb. of cereal are dried to 750 lb. by 10-psig. steam? Initial temperature of the cereal is 60 F. and the final temperature equals that of the steam.

$C = 970(1{,}000 - 750)/952 + (1{,}000)(0.189) = 444$ lb./hr.

For special conditions

With submerged surfaces, when heat-exchange equipment has more area than that needed to heat a specified quantity of liquid in a given time and condensate is withdrawn as rapidly as formed (which usually is desirable), use Table III instead of the formulas above. Condensate rate is found simply by multiplying the submerged area by an appropriate factor from the table. These data can be used for heating water, chemical solutions, oils and other liquids.

When air is heated by being blown over steam coils, you can use Table V if you know the quantity of air and the entering and leaving temperatures. Without the data required for this table, you must use the formula for pipes above and multiply the answer by a safety load factor of 5.

Steam Condensed by Air, Lb./Hr./1,000 Cfm.*—Table V

Temp diff, °F.	Pressure, psig. 5	10	50	100	150
50	61	61	63	66	67
100	120	122	126	132	134
150	180	183	189	198	201
200	240	244	252	264	268
250	300	305	315	330	335
300	360	366	378	396	402

*Based on 0.0192 Btu. absorbed per cu. ft. of saturated air per deg. F. at 32 F. For 0 F., multiply by 1.1

How to Size Trap

To select a trap whose capacity is determined by any of the above formulas, you must use a multiplier or safety factor before you refer to a trap-capacity table. These factors, which ordinarily vary between 2 and 5, are applied to compensate for

handling abnormal amounts of air or condensate, variation in steam pressure and unpredictable operating conditions.

A factor of 2 is used for pressure vessels, submerged surfaces with gravity discharge and steam mains. Pipe coils, dryers and submerged surfaces where condensate is lifted to the trap have factors of 3. For air-blast, finned-type heating coils, the factor is 5.

The importance of the safety factors is emphasized when you realize that the exact condensate load rarely is known and many times is impossible to calculate. Also, safety factors often cover inaccurate assumptions.

Of course, the factors that we mentioned above may vary somewhat from one make of trap to another. So follow the catalog recommendations when you choose a factor.

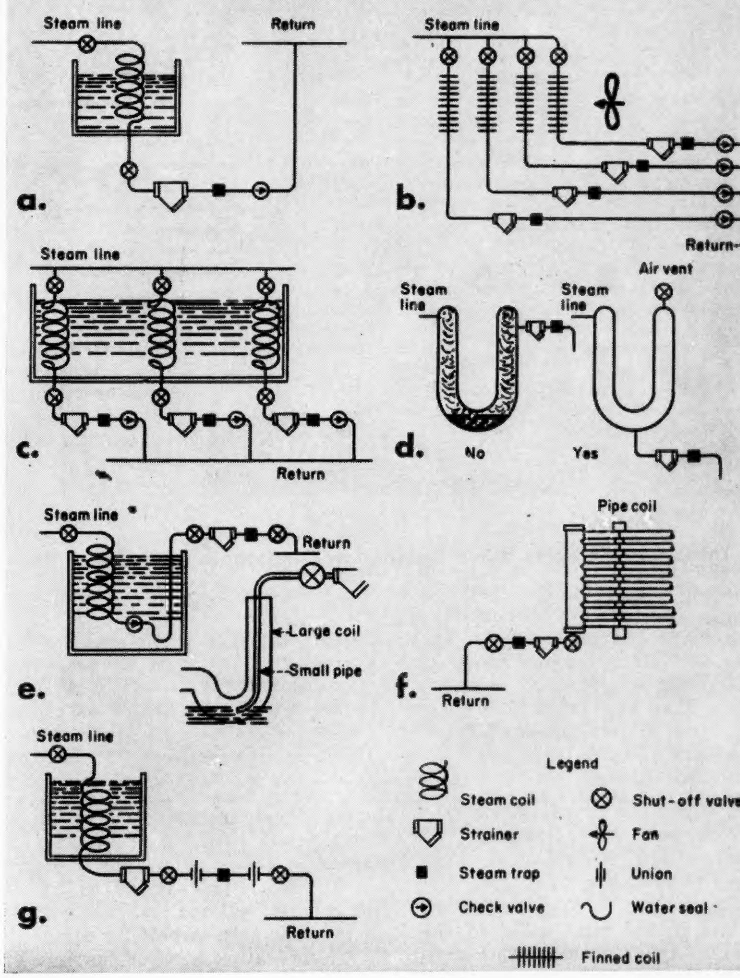
When you choose a size, be sure that you pick a model with a pressure greater than the steam pressure.

Some types of traps are manufactured to cover every steam pressure in the average plant. Others require several models, several orifices, or both, in different pressure ratings to cover such a range.

For a float or bucket trap, be sure that you specify the correct orifice. Six different orifices are needed to cover the range from 0 to 250 psi. These traps will operate at pressures below the orifice rating, but not above.

Determine pressure at the trap inlet, not at the system inlet. Also, check atmospheric conditions so that you may specify stainless steel construction if the area is corrosive.

How to Install Trap for Best Results



How to Install a Trap

No matter how well a trap is designed, it has little chance of delivering peak performance unless it is applied correctly. The first step toward correct application is to install it properly according to the manufacturer's recommendations.

Every manufacturer recommends certain ways to install and maintain his trap. Follow these recommendations carefully.

For chemical-plant equipment, there are certain installation pointers which can be applied to almost every type of trap.

If physically possible, install the trap below the equipment being drained. Sketches above show you several typical chemical-plant units where this recommendation is applied.

Remember to locate the trap so that it is accessible. At the same time it should be close to the unit, unless a cooling leg is required.

Where condensate must be lifted above the level of the trap discharge, install a check valve between discharger and riser. Each foot of lift adds approximately 0.5 psi. to the back pressure. Therefore, make sure that the total backpressure on the trap is within the limits set by the manufacturer.

Check valves should be used where a group of small steam-users are draining through one trap. Also, check valves should be placed after each trap discharging into a common header. This prevents flooding of shutdown units.

To prevent the possibility of steam-binding, pitch horizontal pipe runs slightly toward the trap. Where the condensate must be elevated to the trap use a water seal to prevent steam-binding, as shown in the sketch.

On steam mains, place a trap at each low point. Maximum spacing between traps should not exceed 500 ft. Locate traps at low points of steam headers and ahead of pressure-reducing and other regulating valves.

Be sure you know inlet steam pressure to the trap because it affects capacity directly. And for peak efficiency you should avoid

Ordinary Ranges of Over-All Coefficients of Heat Transfer—Table VI

Type of heat exchanger	State of controlling resistance: Free convection, U	State of controlling resistance: Forced convection, U	Typical Fluid	Typical apparatus
Liquid to liquid	25– 60	150–300	Water	Liquid-to-liquid heat exchangers
Liquid to liquid	5– 10	20– 50	Oil	
Liquid to gas*	1– 3	2– 10	....	Hot-water radiators
Liquid to boiling liquid	20– 60	50–150	Water	Brine coolers
Liquid to boiling liquid	5– 20	25– 60	Oil	
Gas* to liquid	1– 3	2– 10	....	Air coolers, economizers
Gas* to gas	0.6– 2	2– 6	....	Steam superheaters
Gas* to boiling liquid	1– 3	2– 10	....	Steam boilers
Condensing vapor to liquid	50–200	150–800	Steam to water	Liquid heaters and condensers
Condensing vapor to liquid	10– 30	20– 60	Steam to oil	
Condensing vapor to liquid	40– 80	60–150	Organic vapor to water	
Condensing vapor to liquid	....	15–300	Steam-gas mixture	
Condensing vapor to gas*	1– 2	2– 10	....	Steam pipes in air, air heaters
Condensing vapor to boiling liquid	40–100	....	....	Scale-forming evaporators
Condensing vapor to boiling liquid	300–800	....	Steam to water	
Condensing vapor to boiling liquid	50–150	....	Steam to oil	

* At atmospheric pressue.
U = Btu./(hr.)(sq. ft.)(deg. F.) Under many conditions either higher or lower values may be realized.

Use These Specific Heats When Calculating Condensate Load—Table VII

Solids		Liquids	
Aluminum	0.23	Alcohol	0.65
Brass	0.10	Carbon tetrachloride	0.20
Copper	0.10	Gasoline	0.53
Glass	0.20	Glycerin	0.58
Iron	0.13	Kerosene	0.47
Steel	0.12	Oils	0.40–0.50

short circuiting by using one trap for each piece of equipment.

Before you install trap, blow down the inlet line to remove dirt and scale. Use a good fine-screen strainer in the pipe ahead of the trap. A Y-type strainer with Dutch-weave basket gives maximum straining area.

Check the inlet and outlet markings of the trap to see that they are positioned correctly with respect to the piping the trap serves. Fit valves and unions before and after the trap so that it may be removed easily.

If possible, use a tee fitting with a test valve on the discharge side of the trap. That will allow you to check operation of the trap. Also, a shutoff valve ahead of the trap together with a downstream check valve will permit trap to be worked on right in the line.

How to Maintain Traps

Locating trap troubles can be tedious work. Much of this can be avoided by an adequate program of preventive maintenance which should include periodic inspection of traps and cleaning of strainer baskets.

A thermometer inserted in the pipe between coil and trap tells you whether the trap is holding equipment temperature high. A pressure gage on the return tank in the boiler room will show rising pressure if a trap is blowing somewhere or a bypass is open. Similar pressure gages on return lines from different sections of a large plant help isolate such trouble more quickly.

A steel rod or stethoscope can be held against a trap to telegraph operations of the trap mechanism to the listener's ear. But probably the most useful trap testing instrument is the portable pyrometer. With it you can determine trap temperature within 5 deg.

Once you locate a faulty trap, you'll want to find the reason for poor operation (see adjacent check list). If the reason is not readily apparent, observe discharge from the trap by breaking the outlet union or use the test outlet on the downstream side. Clean the strainer screen at the same time.

Reason for Faulty Operation

Trap cold but apparently discharging normally

1. Trap too small. Open strainer blowout to bleed out more condensate. Install larger trap.
2. Strainer plugged, or partially so; full pressure not reaching trap. Clean line and strainer.
3. If thermostatic type, bellows is overstressed so that orifice seat cannot be opened fully. Replace bellows.

Trap cold and not discharging

1. Pressure not reaching trap.
   a. Strainer plugged with dirt. Blow out or replace basket.
   b. Inlet valve to equipment is closed or has broken stem.
   c. Outlet valve in return line from trap is closed or broken.
   d. Line to trap plugged at elbow or nipple.
2. Pressure too high (bucket traps only.)
   a. Pressure-reducing valve in steam supply out of order.
   b. Orifice enlarged by wear.
   c. Wrong orifice installed, too large for bucket to operate.
3. Sufficient pressure, but no flow.
   a. Trap is air locked; vent hole in bucket plugged.
   b. Trap dirty, control orifice plugged.
   c. Worn or defective mechanism.

Trap hot, steam leak suspected

1. No condensate coming to trap due to broken siphon in siphon-drained cylinder, or pinhole leak in siphon tube.
2. Open or leaky bypass valve around trap.
3. Trap may not be closing tightly.
   a. Dirt or scale may be holding valve from seat.
   b. Worn parts; wire-drawn valve or seat.
4. Ruptured bellows.
5. Loss of prime; no water in body to float bucket to closed position. Close inlet valve to apparatus a few minutes to allow water to collect.
6. Is back pressure in line abnormally high?

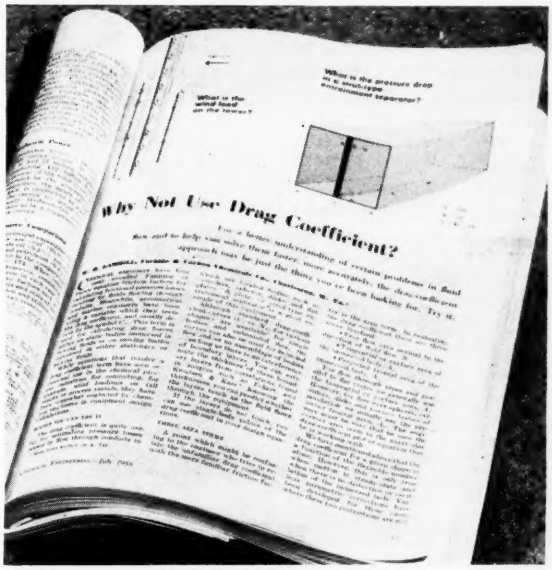
Slow heating

1. Trap too small to discharge the heavy starting load rapidly. Install a larger trap or another trap in parallel.
2. Too much air for trap to handle. Pick a trap with greater air-handling capacity.
3. Short circuiting. Are units trapped individually?
4. Low steam pressure at start of process due to heavy demands elsewhere in plant (especially Monday mornings).

Imaginary troubles

1. Is trap installed in right direction with arrow pointing toward return line?
2. Discharge too hot. Do not confuse flash steam with live steam. Flash steam always forms when a trap discharges very hot condensate to a lower pressure. In fact, if there is no flash steam, trap probably is not operating as it should.

Drag Coefficient Article Arouses Reader Interest



"Usable concept," they say and offer suggestions for other applications. Some hold out for friction factor and other approaches. But all agree that there's certainly some deeper stuff beyond.

Senior Scientist Agrees on Utility

Dear Cecil:

While the drag-coefficient approach has been used extensively in chemical engineering, the article by W. R. Gambill (*Chem. Eng.*, July 1956, p. 177) is appropriate in reminding the readers of the utility of this approach.

The drag-coefficient concept, although generally applicable has been used primarily as a means for expressing flow resistance data for effectively unbounded systems. The friction factor, as usually written, has been primarily an analogous concept for specific use in expressing flow resistance data in bounded systems where the interest is primarily on the energy loss in the fluid phase. In general, however, the two types of coefficients are basically identical.

The Fanning friction factor, f, originally arose as the proportionality factor which relates shear stress at the wall of the pipe, τ_w, to the kinetic energy of the fluid. Thus, by definition:

$$\tau_w = f(\rho V^2/2g) \qquad (1)$$

Therefore, the Fanning friction factor is basically identical to the drag coefficient based on tangential surface, as also shown by Gambill's Eq. (6). The form used by Gambill in Eqs. (1) and (3) is simply the way in which the Fanning friction factor is usually specified, representing a conversion of Eq. (1) above to mechanical energy loss in the fluid.

It should be noted here that the pressure drop as used by Gambill is not really a pressure drop. It is a loss in mechanical energy expressed in pressure units. There are many cases where, in flowing down a system, the fluid pressure will actually rise, although there will always be a net loss of mechanical energy. For more details of this distinction, we refer the reader to Boucher's "Fluid and Particle Mechanics," Chap. 1, Univ. of Delaware, Newark, Del. (1951).

Gambill points out that drag coefficient data for unbounded forms can be applied to bounded systems provided the boundary layers do not touch as the fluid moves through the system. While the boundary-layer thickness is an arbitrary concept, this statement is correct as an approximation. However, the term boundary layer must include the so-called turbulent boundary layer as well as the laminar sublayer.

It should also be remembered that the proximity of boundaries will influence the thickness of the boundary layer. Thus, for refined calculations, it is necessary to have available data on the effect of proximities on the drag coefficient.

The utility of the drag-coefficient concept is usually for flow through short or discrete bodies such as screens, fibers or packings. For longer bounded systems, most of the data are available in the form of friction factors, although there is no reason why they could not convert into a drag-coefficient form. However, this is purely a matter of algebraic transformation or convenience.

The specific example cited by Gambill does illustrate a use of the drag coefficient approach. However, it is a poor choice from the standpoint of expediency since the friction-factor approach is more direct and accurate in that specific case, primarily because it allows for the effect of proximity of walls. The following indicates the general calculation procedure:

For turbulent flow, the usual friction factors for circular pipe have been shown to be applicable to other shaped pipe, provided the diameter term is taken as the hydraulic diameter (four times the hydraulic radius) of the shape in question, and the velocity is taken as the average velocity in the pipe. Thus, for the problem in question:

$$\Delta P = \text{Friction loss} = 0.085 \text{ psi.}$$

The friction loss calculated above is based on friction-factor data for long ducts. Actually, the friction loss at the inlet of the duct will be somewhat higher due to the higher shear stresses at the wall while an equilibrium velocity distribution is being set up.

Therefore, the actual drop experienced in the duct will be somewhat higher, depending also on the nature of the velocity maldistribution existing upstream of

the honeycomb-vaned section. An allowance for inlet-outlet losses should also be added because of the finite thickness of the vanes, but this is negligible in this case.

In Gambill's calculation he inadvertently omitted the gravitational conversion constant. Correcting his value of friction loss, 2.17 psi., for this omission, his calculated friction loss becomes 0.067 psi. as compared to the value of 0.085 psi. found above. Gambill's calculation is based on drag coefficients which do not allow for boundary proximity effects. These effects are included in the friction-factor approach, used in the calculation above.

CHARLES E. LAPPLE
Senior Scientist

Stanford Research Institute
Menlo Park, Calif.

Author Compares Many Published Methods

Dear Ray:

Unfortunately, a reader has pointed out in a letter to me that we let an error slip into the sample problem at the end of the drag-coefficient article.

The gravitational constant, g, which properly appears in Eq. (4), was omitted from the calculation of the drag force, F_D, in the example. So that 402 lb. becomes 12.48 lb. and ΔP becomes 0.0673 psi.

This development also requires modification of the concluding sentence.

Otherwise, the reader thought the article "interesting and stimulating" and desires a tearsheet for his files. I'm enclosing a postscript to my article. The only letter I've received that specifically questions the results of the sample problem was from R. D. Madison, director of research of the Buffalo Forge Co.

Madison notes the g-factor omission and further asks wherein the value that is calculated by his method (Madison, R. D. and W. R. Elliot, "Friction Charts for Gases Including Correction for Temperature, Viscosity and Pipe Roughness," *Heating, Piping & Aid Conditioning*, Oct. 1946, pp. 107-112) differs from my answer.

This letter leads me to believe that other readers might have similar questions. I think that the additional material below will clear this up. It will also lead those who might be interested to the "deeper stuff beyond."

The original purpose of the brief, simplified article on drag coefficient was only to point out the general utility of the drag-coefficient approach. As is always the case with such brief treatments of large areas, many detailed factors of relative importance were necessarily omitted.

In answer to questions that ask why the drag-coefficient solution may not agree with other published methods, let me say this: It must be recognized at the beginning that each of the following variables has a distinct effect upon flow behavior such as that postulated in my sample problem.

- Nature of the flow channel's leading edges, whether flared or sharp edged.
- Initial intensity of turbulence in the approaching stream.
- Surface roughness.
- Frictional heating effects.
- Value of the critical Reynolds number for transition from a laminar to a turbulent boundary layer. This depends in turn on the first three variables above.
- Boundary-layer buildup and consequent acceleration of the central fluid core.
- Possible maldistribution of flow between parallel channels.

Frictional heating, for example will increase the entrance length (the zone in which the velocity profile is not fully developed), although the increase is not large for subsonic flow.[2]

For our sample problem, we have now recalculated the pressure drop using several drag-coefficient correlations. However, we should note first that the length Reynolds number is more accurately 6,600,000. This would give a ΔP equal to 0.0673 psi. in our sample problem. Using other correlations we obtain:

Method	Reference	ΔP, Psi.	F_D, Lb.
Madison f charts	1	0.1409	26.25
Huebicher f chart for square ducts	5	0.083	15.4
Prandtl-von Karman 1/7-th power law	6	0.0685	12.70
Falkner 1/5-th power law	7	0.0693	12.82
Prandtl-Schlichting logarithmic velocity distribution law	8	0.0681	12.61
Above with laminar zone correction[a]	8	0.0648	12.00
Schultz-Grunow	9	0.0669	12.39
Falkner, with laminar zone correction[a]	7	0.0688	12.76

[a]—The laminar zone correction takes into account the existence of a laminar boundary layer up to the point of transition, as dictated by the value of the critical Reynolds number. In our calculations we used a value of 300,000.

We can conclude from the results above that a ΔP slightly less than 0.07 psi. can be expected for the straightening-vane section if the experimental conditions used to verify the drag-coefficient correlations were similar to those in our sample system.

The larger-than-expected difference in values calculated by the Madison f-chart method vs. the other methods is probably due to boundary-layer buildup. The boundary will increase in thickness in the downstream direction, and near the inlet will grow in the same manner as on a flat plate of zero incidence.

We can see that the case we chose for our sample problem involved a great many variables. The interested reader should consult the references below for more detailed information, as this subject in its entirety is quite broad and intricate. The volume by Schlichting is particularly recommended.

WALLACE R. GAMBILL

Union Carbide Nuclear Co.
Oak Ridge, Tenn.

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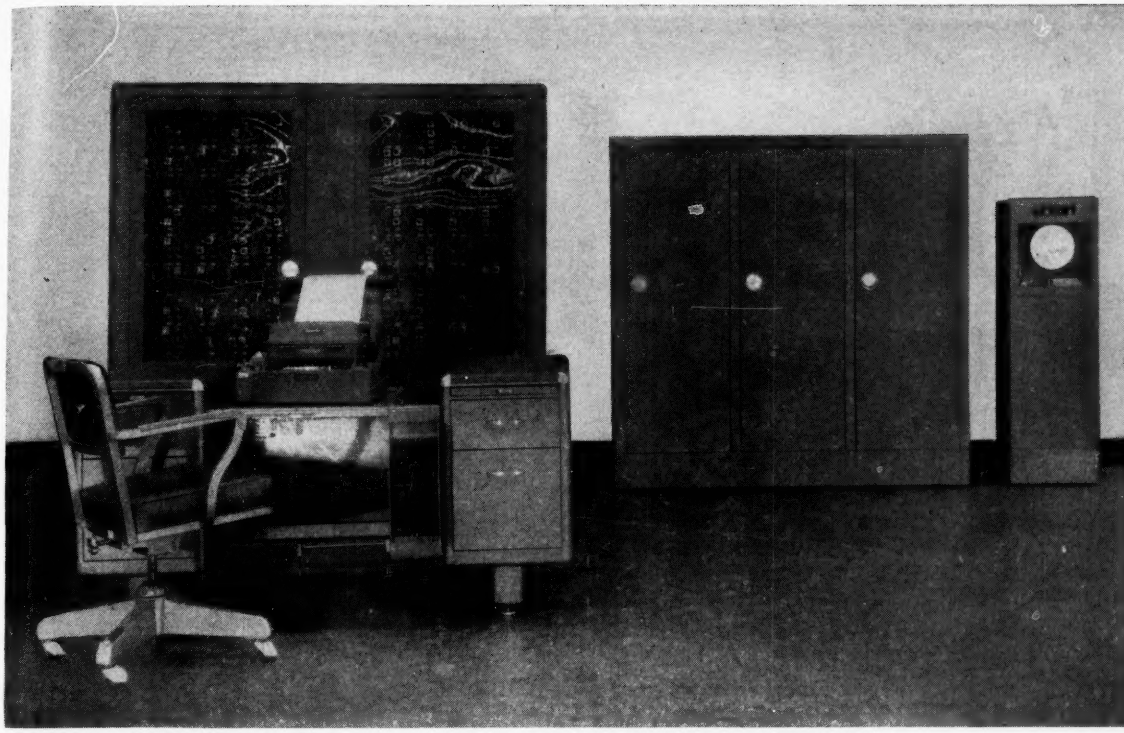


ELECOM COMPUTER at Redstone arsenal used by Author Chu for reactor design calculations.

Update Your Reactor Design Method

The optimum reactor for a given process is one that gives desired product at the lowest cost. This article—last of three parts—tells how computers can help you decide, and what limitations to be wary of.

JU CHIN CHU, Rohm & Haas Co., Huntsville, Ala.*

It takes time for the kinetic study and design of a chemical reactor. But no time should be allocated for such an undertaking if a process shows an unfavorable cost picture on raw material consumption and difficulty of product separation.

Rate of conversion and not the percentage yield is one of the critical factors in determining the optimum size of the industrial reactor.

What tools can we use to help us reach our decision? In the two previous articles in this series (*Chem. Eng.*, Nov. 1956, p. 215 and Dec. 1956, p. 183) we discussed the basic design equations including the kinetic correlation. These equations can be the tools that do the job, if we can manage to manipulate them properly.

Used properly, they can specify the optimum design and, in addition, they can be equally useful in predicting the performance of an existing reactor for a new feed or for a change in throughput or other operating conditions. The change in operating conditions can be due either to a desire to increase plant capacity or to unexpected upset in the actual operation of the plant reactor.

To arrive at optimum design, we must consider costs and credits from all sources. This includes: fixed charges, operating costs, raw material costs and byproduct credits. Major factors that affect the operating cost are power and utility cost, maintenance charges and direct labor.

If we use a catalyst, its regeneration, replacement and fixed charge for holdup within the process system should be considered in our cost evaluation.

To evolve the optimum design, these questions usually have to be answered by the designer:

* Professor Chu of the Polytechnic Institute of Brooklyn carried out the work reported in this article while acting as a summertime consultant to the Rohm & Haas Co., Huntsville, Ala.
To meet your author, see *Chem. Eng.*, Nov. 1956, **p. 410.**

IBM'S LATEST entry in the engineering digital computer field, the magnetic 704.

• Which is the right reactor, a continuously stirred tank, a tubular or some other mechanical design?

• What's the right size? In a tubular reactor, for example, what will happen if 3-in. reactor tubes are used instead of the 1-in. tubes used for experimental work? What's the scale-up factor?

• If the reaction is highly exothermic, will 2-in. tubes be safe to use? Can a much smaller tube be used for continuous operations?

• How long should the reactor be?

• If we plan to recycle, can we use a low recycle ratio to reduce the cost of compression? Can we use a much larger reactor and avoid recycle completely?

• Will increased pressure up the production rate? How high can we go without materially increasing the power cost so that it offsets the advantage of high throughput?

• What's the best way to remove or supply heat? What's the most appropriate heat transfer medium? Can we spray coolant directly into the reactor or between reaction stages?

We can answer many of these questions without recourse to tedious pilot plant work if we have available a sound fundamental correlation of the rate equations, heat-transfer coefficients, heat of reaction and friction factors. Simultaneous solution of our basic design equations and their integration on the basis of proper boundary conditions will provide the quantative answers required for commercial design.

The reactor calculation, if performed in a realistic way, will indicate which variables are important—and which are not—in the performance of the reactor.

Computers Avoid Tedium

Selection of the proper simultaneous equations is tedious and time consuming. When the number of kinetic equations increases because of reaction complexity, we face an even more difficult task. Fortunately, we can overcome the mathematical complexity by using a computer.

Computers not only save substantial amounts of time, but also preserve the mathematical elegance of the fundamental design equations. This is especially true in the case of an analog computer. But let's consider a digital computer such as Whirlwind I at MIT for the purpose of illustration.

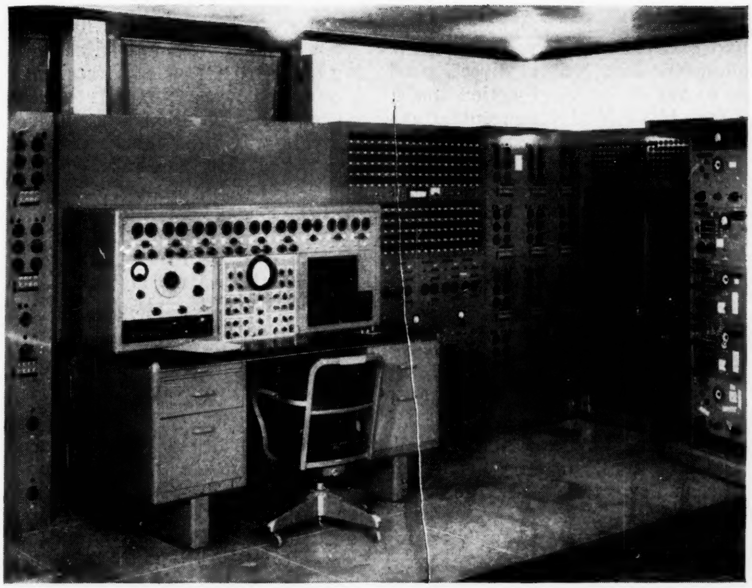
Evaluation of a complete temperature and conversion profile for a noncatalytic, homogeneous, gas-phase reaction in a tubular reactor takes about 30 min. of computer time for a typical run. The entire program used 30 hr. of machine time for 50 sets of operating conditions, plus another 12 hr. for programing and preliminary runs.

On the other hand, the estimated time for hand solution of the same work is about 20 yr. for a good man who makes no mistakes.

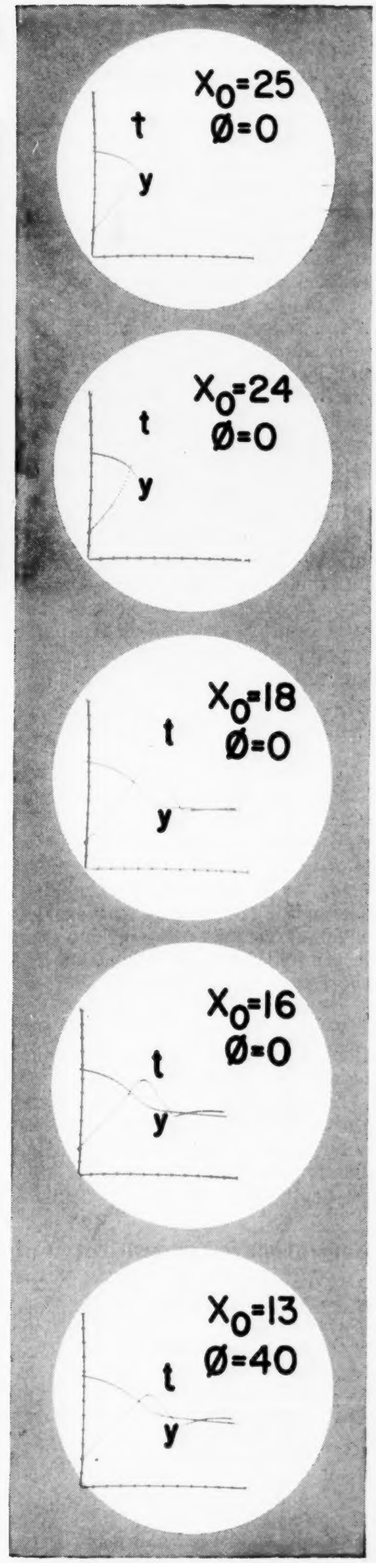
A variety of computers are now available for solving reactor problems. Your choice of a computer depends largely on the specific reactor problem and how it matches the characteristics of different machines.

In our work at Rohm & Haas we used the Elecom 120 (Underwood Corp.) shown on the previous page. This machine is installed at Redstone Arsenal, Huntsville, Ala. The Elecom 120 is no longer being manufactured; it has been replaced by the Elecom 125 System for business and scientific computation. Other machines are available for this type of work. They are the IBM 704 shown above and Sperry Rand's Univac.

Smaller general-purpose digital computers are also available for reactor design problems. They operate at lower speeds but at much less expense. Digital computers, in general, depend on counting techniques to solve mathematical equations. There is no limit of ac-



NEW ANALOG COMPUTER at Calif. Inst. of Technology can graph . . .



. . . REACTOR VARIABLES directly.

curacy on the part of the machine.

Analog computers depend on physical measurements. This limits their accuracy. Simplest analog computer is the slide rule. Here a physical quantity, length, is analogous to the mathematical relation, a table of logarithms. Analog computers are classified into two categories: electromechanical and electronic differential analyzer. The latter is a less expensive and more flexible machine.

Analog computers are useful in exploratory solution of differential equations where an accuracy in the range of 1-10% is sufficient. Initial investment and maintenance costs are low. Relatively little setup time is required for many types of problems. However, for nonlinear problems or for large linear problems, the analog computer is not satisfactory.

Pictured above is a new analog computer in use at the electrical engineering department of the California Institute of Technology. Photo was supplied by Prof. G. D. McCann. With such a computer it's possible to have graphical solutions flashed on the face of an oscilloscope tube.

Simplify the Hand Solution

What can the process engineer do without a computer? Well, he can exercise a great deal of ingenuity to simplify the hand solution. Here's how:

Examine carefully the physical picture on hand to eliminate some unimportant terms and to lump together a number of constants or functions for evaluation. For example, if the equilibrium constant is relatively high, the reaction can be considered irreversible for the purposes of kinetic evaluation. Variation of heat transfer coefficient with temperature, composition and onstream time can be approximated. For a preliminary cost estimate some constant values with enough safety margin can be assumed.

Principal design factors are: composition; temperature; pressure or concentration; and space velocity or time. Optimum values for these factors are interrelated and we must explore all possible combinations. To do this we plot production cost vs. space velocity at several temperatures and one fixed value of pressure. If the use of different pressures proves to be feasible qualitatively, repeat the calculation of production cost for each pressure.

Graphical representation of all the calculated production costs can locate the optimum combination of design factors for the lowest cost.

Because of the amount of work

involved, we seldom carry out a complete analysis of production cost unless it is necessary. It's usual practice to consider the practical situation qualitatively. After we establish the approximate relationship, we can use detailed calculations for a few combinations of design factors.

For example, in the case of endothermic reactions, the temperature is fixed at the highest level permissible for the available materials of construction. Space velocity corresponding to a given temperature and pressure is fixed by purity specification on the finished product. In this particular case, then, operating pressure becomes the only factor that need be investigated economically.

High pressure reduces the reactor size for a specified throughput, but increases the pumping cost for the same rate of production. Several design calculations for total cost of production are made at various temperatures to locate the optimum operating pressure.

Watch These Limitations

The design procedure that we are proposing leads the process engineer to an optimum reactor design without additional, expensive pilot-plant investigation. However, prior to acceptance of the final design for the reactor, the over-all effect of various assumptions used in the mathematical derivation and shortcut calculation should be checked at a few key points.

When you apply kinetic correlations to reactor design, you must be alert to these limitations:

Longitudinal Diffusion—Material balance equations for flow reactors assume that diffusion along the longitudinal direction of flow is negligible. However, *diffusion* of reactants and products occurs under a concentration gradient along the longitudinal direction of flow created by the reaction itself.

Due to their high concentrations downstream, the products tend to diffuse back against the flow.

On the other hand, reactants have a tendency to diffuse forward in the direction of flow. The relative importance of the longitudinal diffusion with respect to other terms in a material balance equation is determined by the concentration gradient within the reactor. In a reactor that is operated at a fixed space velocity, the effect of longitudinal diffusion is negligible if the reactor cross-section is small. The effect may become significant in a shallow reactor of large cross-section.

In a vapor-phase catalytic reactor, the differential material balance is given by:

$$-F\,dN_A + \left(\frac{D_{Am}\pi^2 A}{RT(\pi + \rho_A\sigma_A)N_t}\right)\left(\frac{d^2N_A}{dZ^2}\right)dZ = R\rho_B A\,dZ$$

Integrated expressions that include longitudinal diffusion are available only for a few simplified cases. Even in these cases, there is much uncertainty about the value of mean diffusivity.

Because it is difficult for us to evaluate the effect of longitudinal diffusion, its elimination would be highly desirable. In general, the mass velocity in an industrial reactor is sufficiently high to make the diffusion effect negligible. In the pilot plant, the experimental reactor should be designed to eliminate the effect. If we use a differential reactor, the diffusion effect is negligible because of the small change in concentration.

Danckwertz [*Chem. Eng. Science*, 2, p. 1 (1953)] has analyzed the effect of longitudinal mixing on the distribution of residence time in a flow reactor without agitation. His equation was derived assuming that the reaction is first order and that the rate constant doesn't vary through the reactor.

However, heat of reaction always creates temperature gradient and therefore a point-to-point variation in the rate constant. Also, most industrial reactions are not first-order reactions.

The probability that any molecule will react depends on its path through the reactor as well as its residence time. It depends on which molecules a given molecule encounters in its passage through the reactor. The nature of these encounters is determined by the diffusional processes governed by concentration gradient. And concentration gradient cannot be deduced by the Danckwertz treatment.

Translating Batch Data—Application of reaction rate data of a laboratory batch test to the design of an agitated flow reactor always fails to give the expected result.

This difficulty is due to short circuiting in the system from the inlet to exit of the agitated reactor. For a first-order reaction, average yield from a stirred flow reactor can be approximated by:

$$\int_0^\infty PC'd\left(\frac{F\theta}{M_r}\right)$$

For higher or more complicated order of reaction, no equation has been developed to correct calculated yield to the actual yield that results from short circuiting. Actual yield usually falls between that calculated by the integral above and the yield calculated on the basis of complete mixing.

The curve giving the relation between the relative probability, P, and *fraction of normal residence* time, $F\theta/M_r$, can be determined *for a given geometrical design* by a simple procedure. We refer you to Sherwood's work reported in *Chem. Eng. Progress*, 51, pp. 303-304 (1955).

However, in order to take advantage of Sherwood's procedure, a small flow reactor equipped with an agitator—or an identical geometric design—must be available. But if such a reactor is available, *it might be more convenient to use* it to obtain the kinetic equation

Nomenclature (*Consistent Units*)

A	Cross-sectional area
C_{A_0}	Initial concentration of component A
C'	Fractional yield through the reactor
d	Differential operator
D_{Am}	Mean diffusivity of A through the mixture
F	Mass feed rate
k	Reaction rate coefficient
m	Apparent order of reaction
M_R	Capacity of reactor, lb.
N_A	Moles of A per unit mass of feed passing at any section of the reactor
N_R	Number of reactor units
N_t	Total number of moles of reacting mixture
p_A	Partial pressure of A
P	Relative probability
R	Reaction rate
T	Absolute temperature
Z	Vertical reactor height
θ	Reaction time
θ'	Fractional reaction time
π	Total pressure
ρ_B	Bulk density of catalyst bed
σ_A	Increase in total number of moles of the reacting system per mole of A converted

so that the data suffer no inconsistency from short circuiting.

After all, the average yield calculated from the integral above represents only one limiting value for all cases except the first-order reaction. A small experimental reactor with identical geometrical design should reproduce the mixing condition at the same Reynolds number as that existing in an industrial reactor.

Correct Mechanisms—The term "mechanism" as used by chemical engineers is not the same thing as that used in the past by classical kineticists.

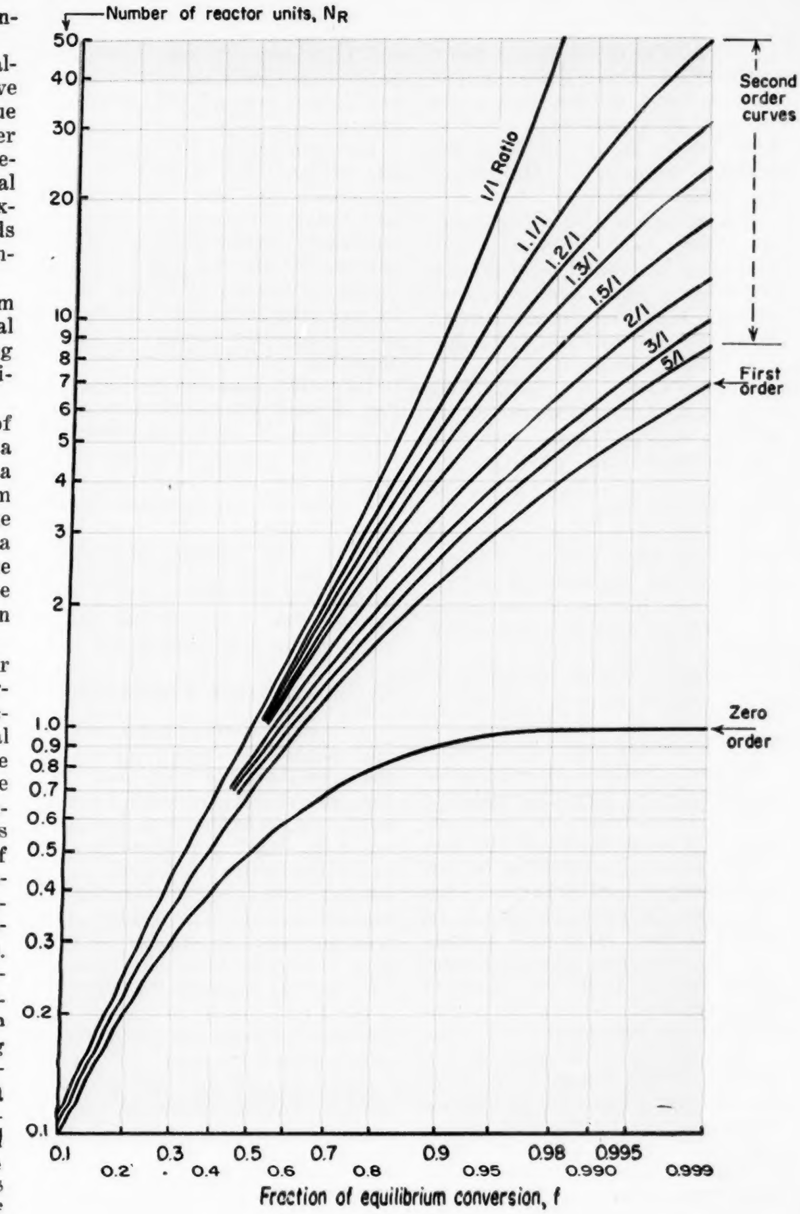
From the engineering point of view, mechanism is based upon a consideration of those steps in a reasonably postulated mechanism which contribute to and control the over-all rate of conversion. In a catalytic reaction we always face the question of whether a surface reaction, adsorption or desorption is controlling.

If the rate of mass transfer across a fluid film controls the over-all rate of conversion, what functions of concentration or partial pressure of each component in the reacting system may appear in the rate equation? The relative importance of each of these factors with respect to the over-all rate of conversion should be well established over the entire range of conditions projected for proposed operations and for future expansions.

It takes time and money to determine correct mechanisms. Sometimes we face the difficult problem of balancing the cost of obtaining additional data vs. the risk involved in not getting adequate data for a complete and reliable correlation. However, in no case should we base our design on inadequate investigation and its ambiguous interpretation. Extrapolation of kinetic data without sound theory and established analogy should be avoided in all cases.

Impurity Accumulation—Very frequently, unreacted reactants after their separation from the product, are returned to the reactor for further conversion.

Often secondary reactions may not be noticed during one-pass laboratory or pilot-plant investigation. Such reactions may yield some compounds which may inhibit the reaction or change the rate of reaction when present in a significant amount.



Continuous recycle may accumulate impurities in the reacting system. In the worst case, deposit may form on the catalyst bed to decrease the activity of the catalyst. Eventually the deposit may plug the flow. For this important reason, kinetic correlations should be checked at average and several extreme operating conditions by prolonged recycle before a design is accepted.

Radial Gradient—In our discussion of a tubular flow reactor, we made no allowance for variation of temperature and concentration in a radial direction normal to the flow of the reacting system. Neglecting the radial gradient is usually satisfactory, especially for endothermic reactions where the heat of reaction is not large.

The proper change in values of over-all heat transfer coefficient for different tube diameters should be sufficient for scale-up.

On the other hand, especially in the case of highly exothermic re-

actions in a packed bed, the temperature in the middle of the bed along its axial direction is always much higher than the average temperature used in the design calculation. Hot spots may occur at these points along the axis and spread to damage the catalyst and the reactor itself.

Complicated mathematical methods have been developed for computing the radial gradient. Introduction of these additional complicated equations would greatly complicate the solution for industrial reactor design.

Another objection to using these methods is the requirement of obtaining kinetic data under a strictly isothermal condition. It may be impossible to do this in an experimental reactor.

Since radial gradient has a more pronounced effect in tubes of larger diameter and rigorous design appears to be impossible, we should be extremely cautious in recommending any increase in tube size over what is used in laboratory or pilot-plant experiments when we consider an industrial reaction that involves a large heat of reaction.

There's always some temptation to use tubes of larger diameter to reduce the number of tubes required. This is especially the case when rate of conversion, in lb. converted/unit wt. of catalyst, is low and a large number of tubes is required to meet large-scale production requirements. The temptation stems mostly from the excessive labor required to pack the industrial tubular reactor.

Wall Effects—The ratio of wall area to reactor volume varies with the size of a reactor. In the experimental reactor the wall area is relatively larger for a unit volume of reactor than we would use in an industrial reactor.

Wall effect on rate of reaction—either catalytic or noncatalytic—should be considered during the design scale-up. Some homogeneous reactions may be catalyzed to some extent by the wall of the reactor if the material of construction used in the experimental reactor had some catalytic effect on the reactants. This effect may have escaped notice during the experiments.

If a different material is used as tube wall for the industrial reactor, the catalytic wall effect may or may not be absent. Even if catalytic effect is present, its quantitative effect on reaction rate will be different because of differences both in materials of construction and in wall area per unit volume of reactor.

For this reason, we suggest the use of the same material of construction for both experimental and industrial reactors. Catalytic wall effect should be identified and correlated with the wall area unit volume of reactor at several ratios of wall area to reactor volume. At least, the ratio should be varied threefold.

Whenever a packed bed of catalyst is used, the so-called noncatalytic effect of tube wall should be reduced to a negligible amount by using a small size catalyst particle. The ratio of tube diameter to particle diameter should be at least 10 to 1. The noncatalytic wall effect is due mostly to the difference in statistical distribution of flow between the center of the packed bed and the part close to the wall.

Avoid Empirical Temptations

A number of simplified empirical approaches have been proposed for the correlation of rate data and for reactor design. One widely publicized technique was first proposed by Hurt for first-order or pseudofirst-order reactions. The method was recently expanded by Caddell and Hurt to include other homogeneous reactions [*Chem. Eng. Progress*, 47, p. 334 (1951)]. The method neglects the effect of several variables as well as the distinction between constant volume and constant pressure.

The empirical approach is based on the equation developed for the number of reactor units, N_R, defined as follows:

$$N_R = k\theta' C_{Ao}^{m-1}$$

Number of reactor units is related to the fractional conversion at equilibrium; the apparent order of reaction, m; and the ratio of reactants. Using the equation above and the Caddell & Hurt chart shown on the previous page, we can determine the rate constant and the apparent order of reaction from laboratory data. Then we can reverse the operation for the purpose of design.

This method has great appeal to most engineers because of its simplicity. Although the extrapolation of experimental data was claimed by the authors to be limited to doubling the maximum or halving the minimum number of reactor units for an accuracy of 10%, great caution should be taken in comparing each specific case with various assumptions involved in the development of the method.

However, for a preliminary cost estimate the Caddell & Hurt method can be used to advantage in saving time.

If the study of reaction mechanism indicates that the diffusion across the fluid film controls the over-all rate of reaction, the sudden expansion and contraction at the end of the reactor may have considerable effect on the rate of mass transfer by diffusion. In turn the rate of mass transfer by diffusion may control the rate of reaction.

The scale-up factor caused by the additional turbulence at the entrance and exit of the reactor should be evaluated in the pilot plant by varying the ratio of reactor length to diameter. If this is not permissible, laboratory data should be secured in a reactor that is much longer than it is wide. In such a reactor, the end effect is relatively small and final design will be on the conservative side.

Additional turbulence created at the end tends to mix the progressive flow in a tubular reactor. This mixing tends to smear the reacting system and decrease the rate of conversion. The smearing effect and its effect on diffusion should be included in your scale-up.

To Sum Up

In these three articles we have presented the application of kinetics to industrial reactor design. We'd like to repeat that the development of rate equations and other necessary design data, as well as the reactor design itself, is a costly undertaking.

In no case should time be allocated for such an undertaking if the result of exploratory studies rules out the economic feasibility.

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How to Stretch Your Equilibrium Data

Need more data for your vapor-liquid equilibrium design calculations? Here's how to get the greatest mileage out of what you already have.

JAMES O. OSBURN, State University of Iowa, Iowa City, Ia.*

WE RARELY have all the data we want. Often we are called upon to finish a design before we have complete equilibrium data. In last month's CE Refresher (*Chem. Eng.*, Dec. 1956, p. 211) we discussed how to use Raoult's law when we have only pure-component vapor pressure data. Then we considered equilibrium ratios for ideal solutions that do not follow this law.

This month we'll consider the problem of extending our data when we have only a limited amount of vapor-liquid equilibrium data. In this case we don't have to assume Raoult's law, nor even ideal solutions. The accuracy of our calculations will show a corresponding improvement.

When Data Are Scarce

To design a fractionation column, we need data on equilibrium between vapor and liquid phases. With these data we can calculate the number of equilibrium contacts that will be required.

If the substances that we are separating form an azeotrope, the equilibrium data will also show the maximum limit of the separation.

It would be fine if we always had complete data available, but often we have to work with whatever we can get. There are many sources of vapor-liquid equilibrium data in the literature; for example, the recent book "Vapor Liquid Equilibrium Data," by Chu, Wang, Levy and Paul, published by T. W. Edwards, Ann Arbor, Mich. (1956). But the available data are few compared with the total number of systems you might possibly run into.

Instead of x-y data covering the complete range of composition and pressure, we may have only a few points. Sometimes we have only one value, an azeotropic composition. See, for example, a list by Horsley, *Ind. & Eng. Chem., Analytical Ed.*, Vol. 19, pp. 508-600 (1947).

If we can't find anything at all in the literature, we may have to measure just a few vapor-liquid equilibrium values. But then we can use our knowledge of thermodynamics to extend the data we get.

First Find the Vapor Pressure

In any event, we'll need vapor pressure data for the pure components. Measurement of vapor pressure is a rather simple exercise in physical chemistry. We can do it quicker and more easily than we can measure vapor and liquid equilibrium compositions.

Also, vapor pressure data for many pure substances have been published. See, for example, Stull, *Ind. & Eng. Chem.*, Vol. 39, pp. 517-570 (1947) and T. E. Jordan's "Vapor Pressure of Organic Compounds," Interscience (1954).

Activity Coefficient Is the Key

We pointed out in our last installment that some mixtures obey Raoult's law. We can calculate with relative ease the vapor-liquid equilibria for such mixtures. Other mixtures may not follow Raoult's law, but may deviate rather significantly.

Fortunately, these deviations are not random. They conform to certain requirements that are imposed by the science of thermodynamics. Based on the laws of thermodynamics equations have been derived, equations that can be used to correlate physically measured deviations from Raoult's law.

If we apply Raoult's law to substance A,

$$\pi y_A = P_A x_A \qquad (1)$$

For nonideal solutions, we introduce a correction factor which we call the activity coefficient, γ. Applying this correction factor to substance A,

$$\gamma_A = \frac{\text{Vapor pressure of } A \text{ above a solution}}{\text{Vapor pressure calculated by Raoult's law}}$$

$$\gamma_A = \pi y_A / P_A x_A \qquad (2)$$

We can write an expression for the activity coefficient of the other component, B, in our system. The expression will be the same as Eq. (2) but with new subscripts. Now we proceed to find how γ_A and γ_B are related to each other.

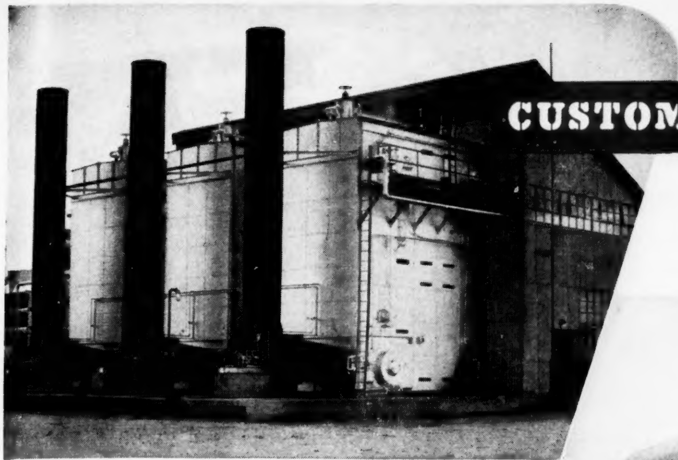
Gibbs-Duhem Equation Is Fundamental

The relationship between the activity coefficients is the Gibbs-Duhem equation. The equation is a relationship between two partial differentials at constant temperature and pressure. It is written in the following form by Carlson and Colburn in *Ind. & Eng. Chem.*, Vol. 34, p. 581 (1942):

$$x_A \left(\frac{\partial \ln \gamma_A}{\partial x_A}\right)_{T,P} = x_B \left(\frac{\partial \ln \gamma_B}{\partial x_B}\right)_{T,P} \qquad (3)$$

As written above for a two-component system, Eq. (3) is perfectly general and doesn't include

* To meet your author see *Chem. Eng.*, Nov. 1956, p. 415.



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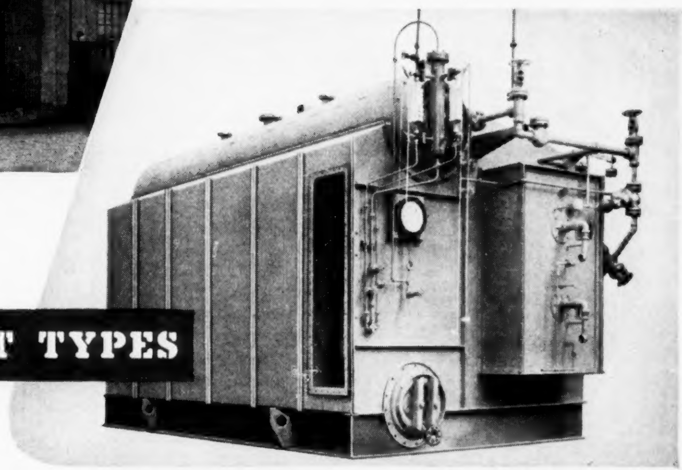

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Nomenclature (Consistent Units)

A, B	Pure substances in equilibrium
C_A, C_B	Constants in the van Laar equations
d	Differential operator
ΔH	Latent heat of a phase change
p	Partial pressure of
P	Absolute pressure
P	Vapor pressure of the pure substance indicated by the subscript
R	Universal gas constant
T	Absolute temperature
x	Mole fraction in the liquid phase
y	Mole fraction in the vapor phase
γ	Activity coefficient
π	Total pressure
∂	Partial differential of

any assumptions. However, before we can use Eq. (3), we must make some assumptions.

For one thing, we can't keep both the temperature and the pressure constant when we have two-component, two-phase equilibrium. Therefore, we must assume that the equation applies even though the temperature varies. Also, some assumption must be made to give an integrated form of Eq. (3). An integrated form will be more useful than the differential form of the equation.

Integration Gives Three Solutions

Integrations of the Gibbs-Duhem equation have been worked out. Three solutions, each based on slightly different assumptions, are well-known. These are the Margules, the van Laar and the Scatchard-Hammer equations.

Of these, the van Laar equations are probably the most useful; and we'll use the van Laar equations in this installment.

The van Laar solutions are:

$$\log \gamma_A = C_A/[1 + (C_A x_A/C_B x_B)]^2 \qquad (4)$$

$$\log \gamma_B = C_B/[1 + (C_B x_B/C_A x_A)]^2 \qquad (5)$$

$$C_A = \log \gamma_A[1 + (x_B \log \gamma_B/x_A \log \gamma_A)]^2 \qquad (6)$$

$$C_B = \log \gamma_B[1 + (x_A \log \gamma_A/x_B \log \gamma_B)]^2 \qquad (7)$$

The meanings of the constants C_A and C_B are shown by the following solutions, derived from Eqs. (4) through (7) by proper substitution of x_A and x_B:

When $x_A = 0$, $\quad \log \gamma_A = C_A$

When $x_A = 1$, $\quad \log \gamma_A = 0 \quad$ and $\quad \gamma_A = 1$

When $x_B = 0$, $\quad \log \gamma_B = C_B$

When $x_B = 1$, $\quad \log \gamma_B = 0 \quad$ and $\quad \gamma_B = 1$

We can use these equations for either constant temperature or constant pressure processes. Since most commercial operations are at constant pressure, that's what we'll use here. Now let's see how we can use the van Laar equations when we don't have enough data for our vapor-liquid equilibrium calculations.

Extend Your Data This Way

First, with only a small amount of data, we can calculate the entire x-y curve. All we need is this information:

- One equilibrium value of vapor and liquid compositions.
- The boiling point of this liquid.
- Vapor pressure curves for the pure components.

With more points we could get more precise results, but we can get along with only one. This point need not be the azeotropic composition, although when an azeotrope exists, its composition and boiling point are often known more accurately than other points. And this makes the azeotrope a good place to start.

Let's Look At an Example

Here's how we calculate the x-y curve from data on an azeotrope.

Problem—Calculate the x-y diagram for the hypothetical substances A and B. There is an azeotrope containing 80% A, 20% B on a mole basis, and its boiling point is 75 C. at 760 mm. of Hg pressure. Vapor pressure curves for A and B are included as part of the chart below.

Solution—First we'll calculate the activity coefficients, γ_A and γ_B. Vapor pressures at 75 C. are: $P_A = 634$ mm.; $P_B = 289$ mm.

For an azeotropic composition, $x = y$, and Eq. (2) becomes:

$$\gamma_A = \pi/P_A$$

$$\gamma_A = 760/634 = 1.199$$

$$\gamma_B = 760/289 = 2.630$$

Next we calculate values for C_A and C_B using Eqs. (6) and (7).

$$C_A = \log 1.199 \left[1 + \frac{(0.2)(\log 2.630)}{(0.8)(\log 1.199)}\right]^2$$

$$C_A = 0.4286$$

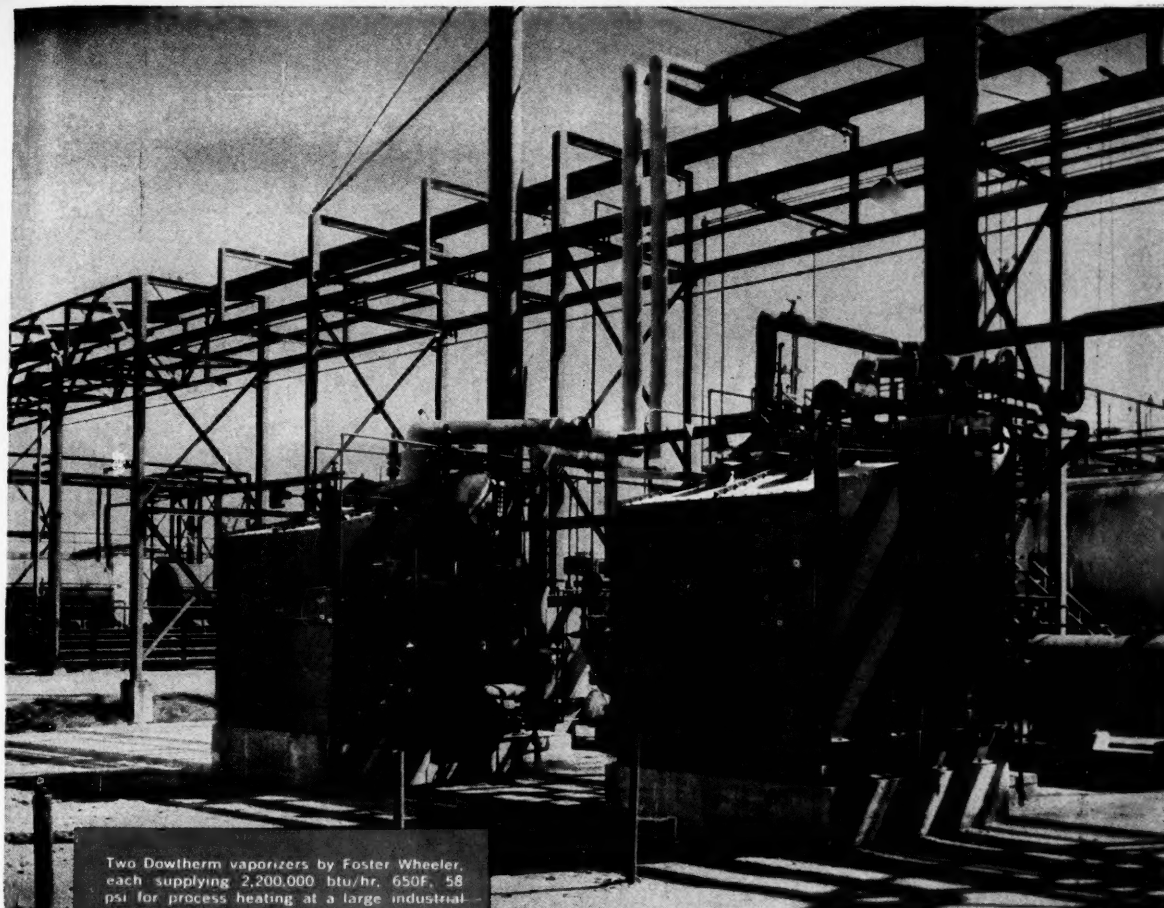
$$C_B = \log 2.630 \left[1 + \frac{(0.8)(\log 1.199)}{(0.2)(\log 2.630)}\right]^2$$

$$C_B = 1.2863$$

With these values for C_A and C_B, we calculate values of activity coefficient for assumed values of x. This gives us the complete γ-x curve. For example, for $x_A = 0.1$, we find that:

Assume Values for x and Calculate Activity Coefficients

x_A	x_B	$C_A x_A$	$C_B x_B$	$\left[1 + \frac{C_A x_A}{C_B x_B}\right]^2$	$\left[1 + \frac{C_B x_B}{C_A x_A}\right]^2$	$\log \gamma_A$	$\log \gamma_B$	γ_A	γ_B
0	1.0	0	1.2863	1.0000	∞	0.4286	0	2.683	1.000
0.1	0.9	0.0429	1.1577	1.0756	781.40	0.3984	0.0016	2.504	1.004
0.3	0.7	0.1286	0.9004	1.3060	64.050	0.3282	0.0201	2.129	1.047
0.5	0.5	0.2143	0.6432	1.7774	16.009	0.2411	0.0803	1.742	1.203
0.7	0.3	0.3000	0.3859	3.1471	5.2533	0.1362	0.2449	1.368	1.758
0.9	0.1	0.3857	0.1286	15.9936	1.7780	0.0268	0.7235	1.064	5.291
1.0	0	0.4286	0	∞	1.2863	0	1.2863	1.000	19.330



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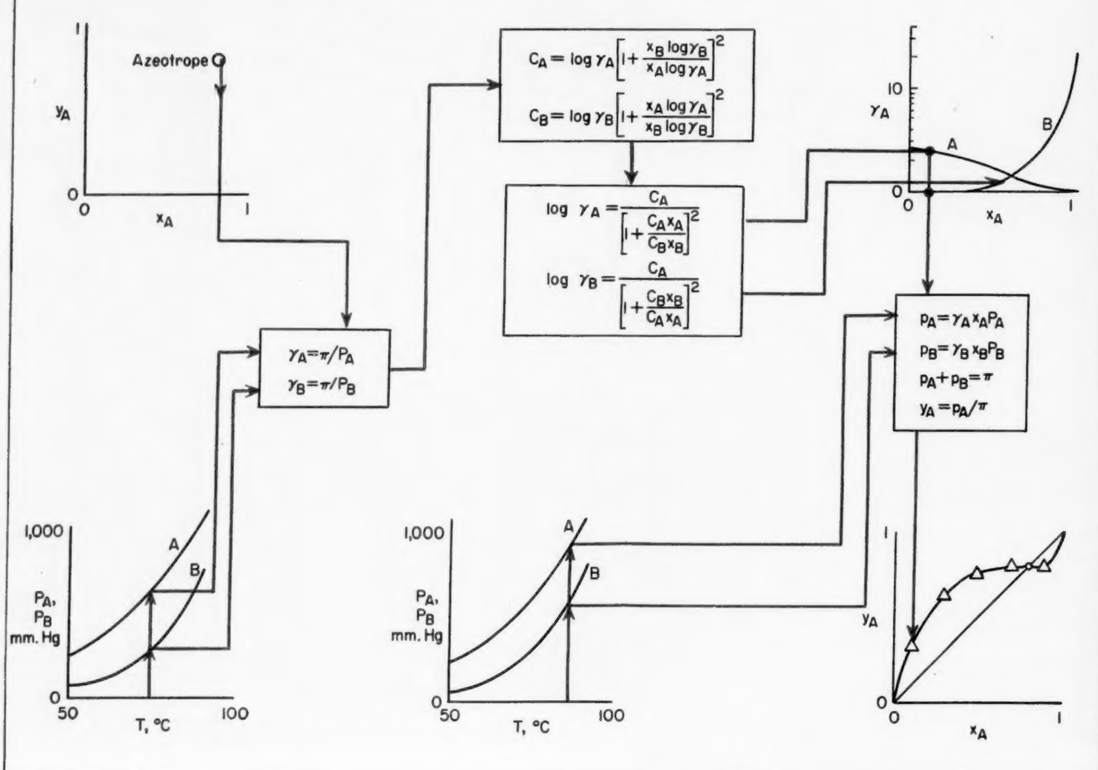
Flow Diagram Helps Calculate x-y Curve From Azeotrope



$$\log \gamma_A = 0.4286 \Big/ \left[1 + \frac{(0.4286)(0.1)}{(1.2863)(0.9)}\right]^2 = 0.3984$$

$$\gamma_A = 2.504$$

$$\log \gamma_B = 1.2863 \Big/ \left[1 + \frac{(1.2863)(0.9)}{(0.4286)(0.1)}\right]^2 = 0.0016$$

$$\gamma_B = 1.004$$

Other values have been summarized in the table on the previous page. Now we can choose a value of x and calculate y. These equations must be satisfied:

$$p_A = \gamma_A x_A P_A \quad (8)$$

$$p_B = \gamma_B x_B P_B \quad (9)$$

$$p_A + p_B = 760 \quad (10)$$

$$y_A = p_A/760 \quad (11)$$

Since we must know the temperature to find P_A and P_B, we'll have to try a temperature, then check the assumed value by Eq. (10). For $x_A = 0.10$, $x_B = 0.90$, assume that the temperature is 86.0 C., where $P_A = 940$ mm. Hg and $P_B = 581$ mm. Then,

$$p_A = (2.504)(0.10)(940) = 235$$

$$p_B = (1.004)(0.90)(581) = 525$$

Total 760

Since $p_A + p_B = 760$, our assumed temperature was correct, and we may proceed to calculate y_A.

$$y_A = 235/760 = 0.310$$

Other equilibrium points are found by the same procedure, as shown in the table below.

Calculations for the x-y Curve

	Trial Temperatures				
	86 C.	79.5 C.	76 C.	75 C.	75 C.
x_A	0.10	0.30	0.50	0.70	0.90
x_B	0.90	0.70	0.50	0.30	0.10
γ_A	2.504	2.129	1.742	1.368	1.064
γ_B	1.004	1.047	1.203	1.758	5.291
P_A	940	747	658	634	634
P_B	581	385	309	289	289
$P_A x_A \gamma_A$	235	477	573	607	607
$P_B x_B \gamma_B$	525	282	186	152	153
π	760	759	759	759	760
y_A	0.31	0.63	0.75	0.80	0.80

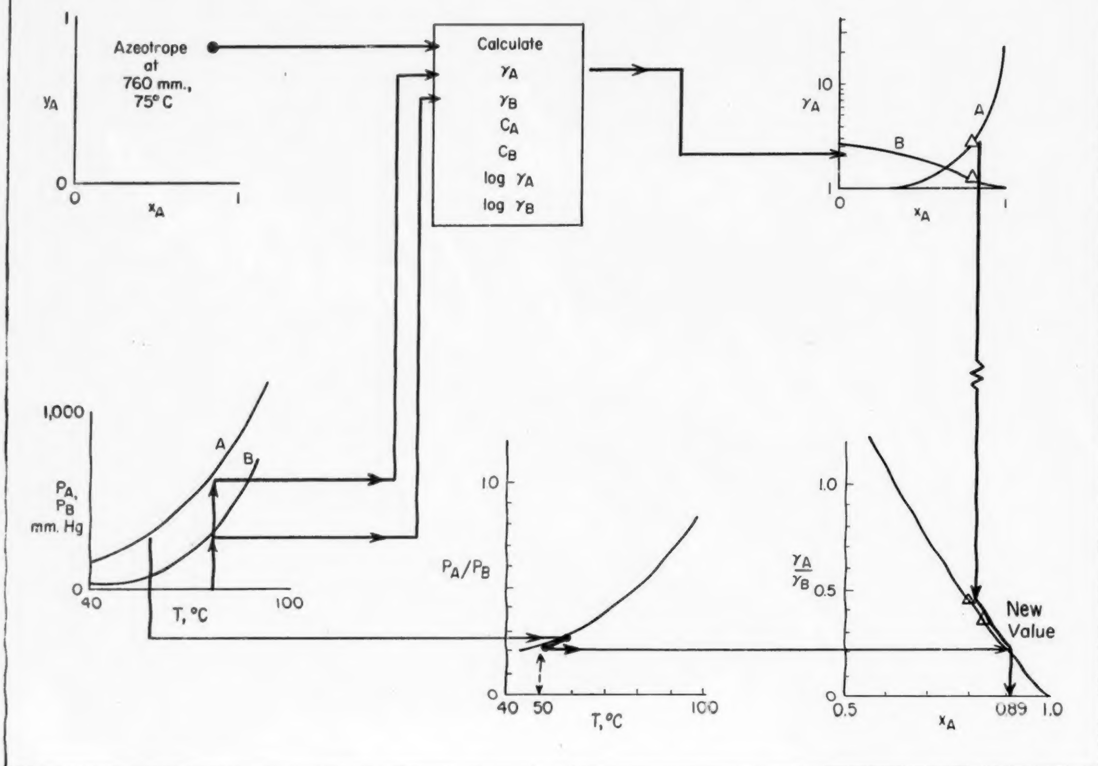
How to Predict an Azeotrope

An azeotrope limits the separation we can get by simple distillation. We can only approach the azeotropic composition, and if we want greater purity we have to use some other method.

Sometimes we can get around this difficulty by operating at a lower or a higher pressure. Under these conditions, the azeotropic composition changes and may even disappear.

In another situation there might be an azeotrope

Flow Diagram Helps Calculate Change in Azeotropic Condition



at a higher pressure and none at atmospheric. If we wanted to go to higher pressure for some reason, the presence of an azeotrope would be a serious consideration. Therefore, a method for predicting azeotropism is very useful.

We can use the activity coefficient for this purpose. One additional assumption will be required, though. We must assume that the ratio of activity coefficients is not affected by changes in temperature.

At the azeotropic compositon, where $x = y$, Eq. (1) becomes:

$$\pi = \gamma_A P_A = \gamma_B P_B$$

Now we divide to get,

$$\gamma_A P_A / \gamma_B P_B = 1$$

$$\gamma_A / \gamma_B = P_B / P_A \qquad (12)$$

Remember that this equation applies only to azeotropes. To show how it is used, let's continue with the hypothetical system *A* and *B* used in the previous example.

Sample Problem: Predict the Azeotrope

Problem—Suppose we want to operate at a lower pressure, where the boiling point of the azeotrope is 50 C. What is the azeotropic composition at this pressure?

Solution—In the calculation flow diagram above, we've diagrammed the steps of the solution. To begin, from the azeotropic composition at 760 mm., calculate the γ-x curve. This is the same as the first three steps in the previous problem.

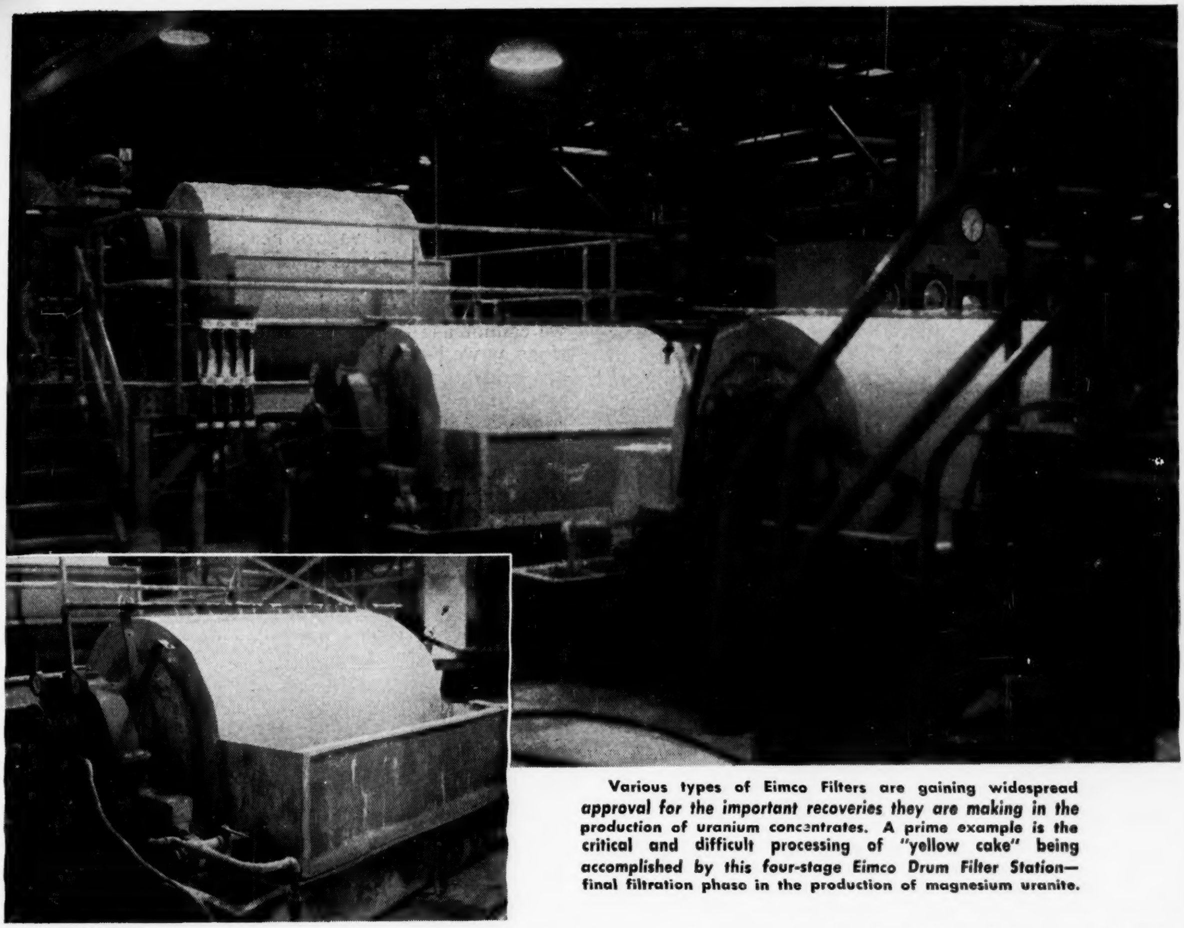
Next, we calculate the ratio γ_A/γ_B, and plot this ratio against x_A. From the vapor pressure curves, calculate the ratio P_B/P_A, and plot against temperature.

Our next step is to put these two plots side by

Calculated Values Used to Predict Azeotrope

Temp., °C.	P_A	P_B	P_B/P_A
50.0	231	53	0.229
57.0	314	83.7	0.266
66.0	450	158	0.351
75.0	634	289	0.456
80.4	770	408	0.530
90.6	1,102	769	0.698
96.0	1,320	1,056	0.800
x_A	γ_A	γ_B	γ_A/γ_B
0.5	1.742	1.203	1.448
0.7	1.368	1.758	0.778
0.8	1.199	2.630	0.456
0.9	1.064	5.291	0.201

Editor's Note—On the flow diagram above the ratio P_A/P_B should read P_B/P_A.



Various types of Eimco Filters are gaining widespread approval for the important recoveries they are making in the production of uranium concentrates. A prime example is the critical and difficult processing of "yellow cake" being accomplished by this four-stage Eimco Drum Filter Station—final filtration phase in the production of magnesium uranite.

EIMCOS FILL TOUGH ROLE FOR URANIUM FIRM

A Canadian Uranium Corporation relies on a four-stage Eimco Drum Filter Station to wash and filter a uranium precipitate in the production of dry magnesium uranite.

The processing method used on mined ore includes a sulphuric acid leach on 55 to 62% minus 200 solids followed by a two-stage drum filtration to separate pregnant liquor from gangue solids.

After clarification and ionic exchange processes, the uranium is precipitated with magnesium oxide in a batch operation, and the slurry is thickened prior to final processing. The precipitate goes thru an initial filtration stage and three subsequent stages of repulping and filtering.

In these filtering stages, the main objective is removal of chloride contamination from the yellow cake. The Eimco Drum Filters are performing very satisfactorily under operating conditions made extremely difficult by physical characteristics of the solids.

The thin cakes exhibit severe cracking tendencies and are very adhesive, which makes washing and cake discharge difficult.

Washing becomes ineffective when wash water is short circuited thru cracks in the cake. To minimize this adversity, Eimco Drum Filters permit washing close to the slurry level, assuring a moist cake surface.

Eimco's roller-type discharge assembly gets complete cake removal that cannot be achieved by a scraper. The rollers exert a preferential sticking force at the discharge point, completely ejecting the yellow cake. Even though a scraper is set in contact with the medium, it does not get complete removal and medium life is short.

By combination of displacement, dilution and washing in three stages, 98% of the contaminate is removed with 100% recovery of solids.

Eimco's follow-up and service policy has resulted in better performance than the customer ever anticipated.

Let Eimco's Research and Development Center at Palatine, Ill., work hand in hand with you to solve your filtration problem.

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EIMCO

B-231

side as shown in the flow chart. For the desired temperature, read the corresponding value of P_B/P_A. Following the value to the other graph, we have the condition for which there is an azeotrope, that is, P_B/P_A is equal to γ_A/γ_B. We intersect the γ_A/γ_B curve at the azeotropic composition x_A.

When the temperature is 50 C., $x_A = 0.89$. For this system the azeotrope moves toward higher values of x_A as the pressure is reduced.

If we want to know the pressure for these new conditions, we must know how the activity coefficients vary with temperature. According to Treybal ["Liquid Extraction," p. 53, McGraw-Hill Book Co., Inc., New York (1950)], the logarithm of the activity coefficient is approximately proportional to the reciprocal of the temperature:

$$\log \gamma \text{ at } T_1/\log \gamma \text{ at } T_2 = T_2/T_1 \qquad (13)$$

This relationship is not general, but we can use it if we have nothing better.

To continue with the illustration, let's calculate the pressure. First we need the activity coefficient at 50 C., for $x_A = 0.89$.

At 760 mm. the boiling point for $x_A = 0.89$ is 75 C. This calculation was shown in the first illustration. Also at this pressure,

$$\log \gamma_A = 0.0314 \quad \text{and} \quad \log \gamma_B = 0.6843$$

We calculate the activity coefficient at 50 C. by using Eq. (13):

$$\log \gamma_A = 0.0314\left(\frac{273+75}{273+50}\right) = 0.0338$$

$$\gamma_A = 1.080$$

$$\log \gamma_B = (0.6843)(348/323) = 0.7372$$

$$\gamma_B = 5.460$$

Vapor pressures at 50 C., are: $P_A = 290$ mm.; $P_B = 72$ mm. Therefore, the partial pressures at 50 C. are:

$$p_A = (1.081)(0.89)(290) = 279$$

$$p_B = (5.460)(0.11)(72) = 43$$

$$\text{Total} \quad 322 \text{ mm.}$$

To summarize, as the boiling point of the azeotrope in this system drops from 75 C. to 50 C., the composition of the azeotrope rises from 80% A to 89% A, and the pressure changes from atmospheric to 322 mm.

Joffe [*Ind. & Eng. Chem.*, 47, p. 2,533 (1955)] tested this method for five systems for which azeotropic data at several pressures have been measured. He reached this conclusion:

When both substances are organic, the calculated values agree well with the experimental. When one of the components is water, you get a better correlation by assuming that the activity coefficient is independent of temperature. The average deviation from the observed values was 0.014 mole fraction. You can use the method with some confidence. It may save you some headaches if you make a few simple calculations before you change pressures.

Are The Assumptions Valid?

The calculations we have made depend on a number of assumptions. How can we be sure that they are valid? Before we go any further, let's look at them and see where they are likely to hold, where they may fall down.

First we assumed that the vapor behaves as an ideal gas. The ideal gas law applies best at high temperature or low pressure. It does not hold very well for saturated vapors near the critical point. You can get an idea of how far from ideal a vapor is by looking at a compressibility factor chart.

If the compressibility factor is too far from 1.0, we cannot use the Gibbs-Duhem or van Laar equations as we have described. However, the equations are still good. But we have to use fugacities instead of pressures when we calculate activity coefficients. We find the fugacities from a fugacity correlation chart (CE Refresher, *Chem. Eng.*, April 1954, p. 215) on which the fugacity is correlated with reduced temperature and pressure.

Another assumption was that the Gibbs-Duhem equation would apply to equilibrium data at variable temperature, although it was derived for constant temperature. To correct for this assumption, Ihl and Dodge [*Chem. Eng. Science*, 2, 120 (1953)] have derived the following modified form of the Gibbs-Duhem equation:

$$x_A\left(\frac{\partial \ln \gamma_A}{\partial x_A}\right)_P = x_B\left(\frac{\partial \ln \gamma_B}{\partial x_B}\right)_P + \frac{\Delta H\, dT}{RT^2\, dx}$$

The term dT/dx is the slope of the boiling-point line and ΔH is the heat of vaporization of 1 lb. mole of solution. Thus, we see that the error in neglecting the correction term is greatest when the components have a wide range of boiling points.

But in this situation, separation is easy and accuracy in equilibrium data is not so important. At the azeotropic composition, we have a maximum or minimum boiling point, so the slope of the boiling-point curve is zero. The correction term is zero for this composition, although it is not zero for the whole range of compositions.

Some authors such as Robinson and Gilliland, "Elements of Fractional Distillation," 4th. Ed., p. 58, McGraw-Hill Book Co., Inc., New York (1950), write Eq. (4) as follows:

$$T(\log \gamma_A) = C_A\Big/\left[1 + \frac{C_A x_A}{C_B x_B}\right]^2$$

We are on a sounder theoretical basis when we include the temperature term, but we'll have a lot more trouble using the equations. This is probably not justified, because of all the other approximations involved.

More Uses Next Month

Next month we'll take up methods of obtaining and testing data, and show how the equations we have just discussed can be useful. In addition, we'll look at the Margules equations, which sometimes work better than the van Laar equations.

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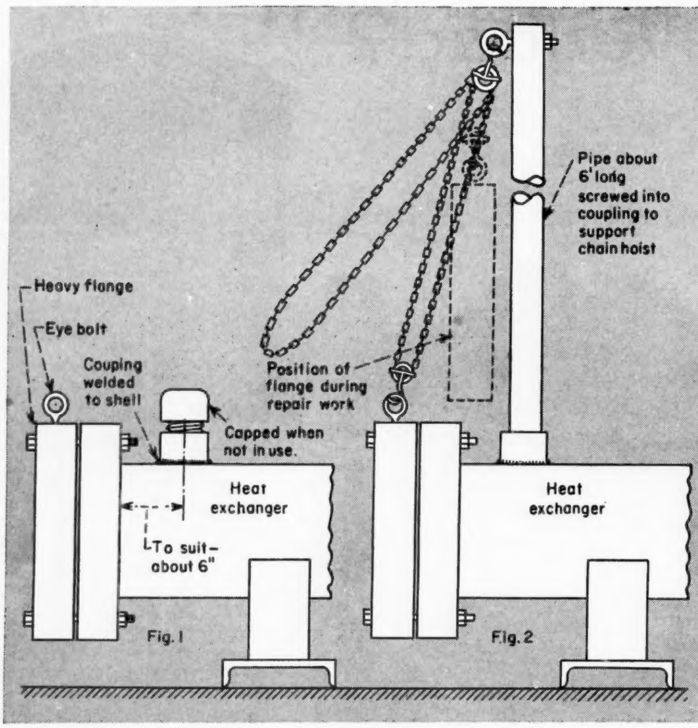
PLANT NOTEBOOK EDITED BY T. R. OLIVE



★ Winner of October Contest

"Sky Hook" for Equipment Repairs

Often a little extra thought during design can save much work when repair is needed. Here's an example.

Edward J. Gibbons
Research & Development Dept., Colgate-Palmolive Co., Jersey City, N. J.

Many times the weight of plant equipment parts, such as condenser and heat exchanger end flanges, is great enough to slow down maintenance.

An economical and effective way to solve this problem is to weld pipe couplings to the shell near the flanges. Then a pipe can quickly be screwed into place when needed to provide an overhead support for a chain hoist to remove the flange. This "sky hook" eliminates need for an A-frame, extra rope slings, timbers and other rigging paraphernalia, and their setup time.

The method is particularly useful in yards and on open platforms where there is usually nothing overhead from which to take a lift.

This trick can also be applied to inspection doors. It can be used to remove heavy-duty agitators from tanks, to lower heavy valves from overhead lines, and for similar situations.

The sketch (Fig. 1) shows a coupling welded onto the shell. In Fig. 2 the pipe is shown in place, with the chain hoist attached. The pipe can be kept on hand and the coupling closed with a capped nipple when the hoist is not in use.

Plasticized Sulfur Useful For Many Purposes

Stasys Maziliauskis

Waltham Grinding Wheel Co.
Waltham, Mass.

Plasticized sulfur can replace a number of resins and cements, and even certain low-melting metals, in various applications of sealing, caulking, impregnation, lining and protective coating. Some of its uses include forming centers for grinding wheels, caulking joints in bell-and-spigot pipe (cast iron, ceramic, etc.), and setting tiles in tanks, floors, sumps and drains. It is low in cost and possesses characteristics that make it not only competitive with other materials, but even outstanding in some cases.

Plasticized sulfur is usually extended and modified by various fillers. It melts quickly and forms a homogeneous mixture which is highly fluid and easily fills small openings and irregularities. It hardens in a few minutes and forms a strong stone-like body which adheres well to nearly everything.

Commercial plasticized sulfur, produced as a silica- or carbon-filled sulfur cement for less expensive corrosion-proof construction, is not always suitable for other applications. Therefore, it must sometimes be compounded on the job, especially for a particular use.

How much plasticizer is needed depends on the intended use. Under ordinary conditions, 1% is sufficient. In most cases the plasticizer is dissolved in the molten sulfur at 120-140 C.

Various materials can be used to plasticize the sulfur, among them, Thiokol A (Thiokol Corp.), Aroclors (Bakelite Co.), Halowax (Halowax Products Div., Union Carbide & Carbon Co.), and other substances compatible in melting range and solubility with sulfur. Probably the best so far is Thiokol A (polyethylene tetrasulfide). Adding a small proportion of wood rosin to Thiokol is helpful. (*Turn to p.* 256.)

New Revolutionary Steam Trap

One large capacity seat for all pressures!

New Sarco Thermodynamic steam trap. Sizes ⅜ to 1"...each body as small as a tee fitting! Capacity is determined, not by a bulky body, but by the effective orifice, valve action, pressure drop and condensate temperature.

1. Cuts trap inventory
With the revolutionary Sarco TD steam trap, you use exactly the same trap...with exactly the same large capacity seat...for all pressures 10-600 psi...for heavy, light or no condensate load. Sizes ⅜ to 1".

2. All pressures 10 to even 600 psi!
...without changes or adjustments. Self-adjusting. High pressure construction...at a low pressure trap price!

3. Operates perfectly when pressure fluctuates
Absolutely no effect even from 600 to 10 psi! No water seal to evaporate. No adjustments.

4. Widest capacity range
Same large capacity seat for 10 as for 600 psi. Pressures of incoming air and condensate INSTANTLY AND FULLY raises valve head (disc), permitting maximum discharge.

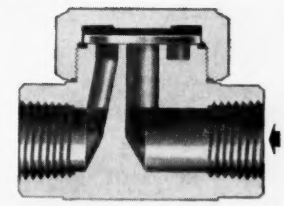
5. Operates equally well on all loads
The same Sarco TD trap for heavy, light or no condensate load. No prime to lose. No adjustments.

6. No oversizing worries
You can size the new Sarco TD steam trap for peak condensate loads...without risk of blowing steam on light loads...no prime to lose...no adjustments.

7. No steam leak required
...to operate the revolutionary Sarco TD steam trap (Pat. Pending). Closes tight against steam!

Convince yourself by 60-day trial...use coupon

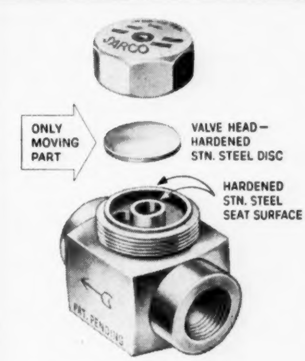
SARCO



Trouble-free design

Here is a trap so simple, it doesn't even have a valve closing mechanism. The kinetic energy of steam closes the valve. ONLY the new Sarco TD uses this operating principle.

No mechanism parts to wear or stick. No narrow channels to choke. No gaskets to leak.



Maintenance practically eliminated

The all-stainless steel Sarco TD has only 3 parts...cap, disc and body. Only moving part is a hardened SOLID stainless steel disc, practically wear-proof.

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Please send me Sarco TD Steam Trap and strainer for 60-day trial.
Size_____ For use on_____

Name_____

Firm_____

Address_____

City_____ **State**_____

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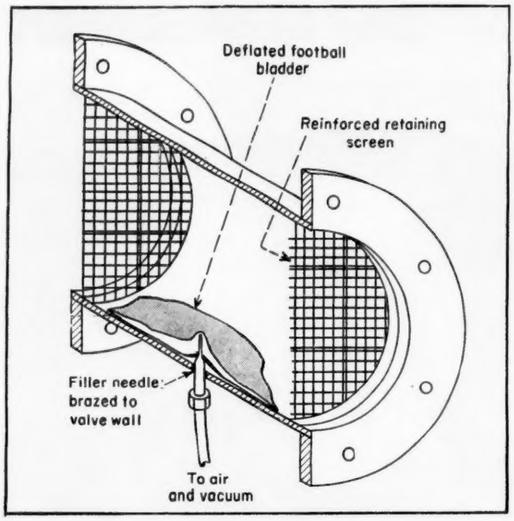
★ $100 Annual Prize Winner for 1956*

"Bladder Valve" Seals Circular Ducts

Victor Pratt

Chemical Engineer, Engineering Research Division, Fort Detrick, Frederick, Md.



In operating certain test chambers we had to purge the gaseous contents to reduce the contaminants periodically before starting another series of tests.

The chamber was equipped with 6-in. sheet metal ducts for purging air supply and exhaust. It was desirable to have remote-operated valves in both ducts. However, it was necessary that the valves be very light in weight. Also, they should give positive shutoff, and be reasonable in cost. No leakage of exhaust air through any part of the valve would be permissible.

We knew of no commercial valve which would meet all these requirements. Hence it was necessary to design and build a new type valve which we called a "bladder valve" because of the nature of the sealing element. This is simply a small football bladder which is installed in an 8-in. long flanged section of circular duct. The filler needle (supplied with the football for inflating) is brazed through the valve wall with a copper tube fitting attached on the outside.

At either end of the 8-in. long valve body a retaining screen is mounted to limit the longitudinal expansion of the bladder when it is inflated, and to force the bladder to fill the valve cavity. Since the bladder is elastic, it will fill the valve entirely, taking the shape of the valve body, and producing a tight seal.

In the sketch it will be noted that a copper line is attached to the filler needle. This line is routed to a control panel where it can be supplied with either 2-psig. air for inflation, or 20-in. Hg vacuum for deflation of the bladder.

Valves of this type have been used satisfactorily for over 5 years. Bladder replacement has been required only once or twice per year. However, attempts to use this principle for larger valves, with larger bladders, have been of limited usefulness owing to variable quality of the rubber. Instead, successful valving of larger ducts has been accomplished by manifolding a sufficient number of valves of the 6-in. size.

* This article, reprinted from the June 1956 issue, has been selected by the editors as the best monthly Plant Notebook winner of the year. The author will therefore receive an additional prize of $100. Readers can meet the author on p. 297.

Various fillers can be used. The first to be considered is silica of 360 mesh or finer, which is commercially available at low cost. Other possible fillers include finely pulverized coal and glass fibers. The finer the filler, and the less filler is used, the better is the fluidity of the sulfur. However, in some cases the quantity of filler used may go as high as 60%.

In melting sulfur cements it is advisable to use a thermostatically controlled melting pot to avoid formation of SO_2.

In certain specialized cases, for example, when very narrow spaces are to be filled, it may be beneficial to inject the molten cement under pressure.

★ Winner of November Contest—Gerald A. Lessells

"Ratio Feeder Gives Constant Delivery"

How Readers Can Win . . .

$50 Prize for a Good Idea—Until further notice the Editors of *Chemical Engineering* will award $50 cash each month to the author of the best short article received that month and accepted for the Plant Notebook.

Each month's winner will be announced in the issue of the second following month, and published the third following month.

$100 Annual Prize—At the end of each year the monthly winners will be rejudged and the year's best winner awarded an additional $100 prize.

How to Enter Contest—Any reader (except McGraw-Hill employees) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable non-winning articles will be published at space rates ($10 min.).

Articles may deal with plant or production "kinks," or novel means of presenting useful data, of interest to chemical engineers. Address Plant Notebook Editor, *Chemical Engineering*, 330 West 42nd St., New York 36, N. Y.

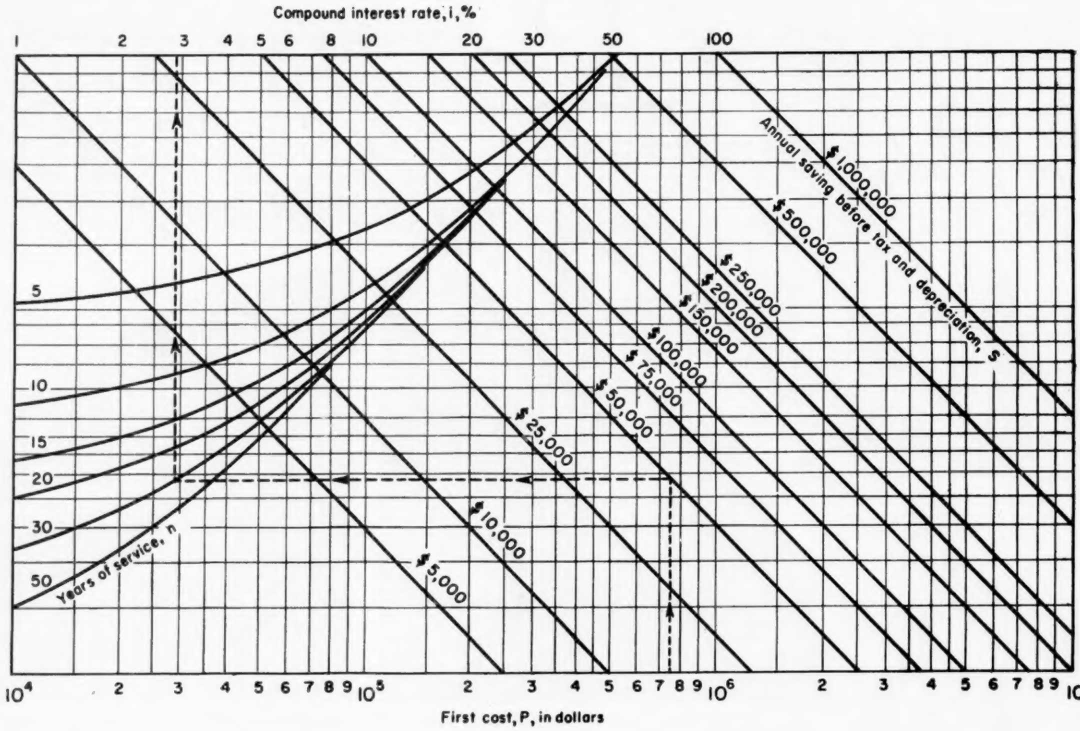


Chart for Net Return of Investment After Taxes

James Chou

Hawaiian Commercial & Sugar Co., Maui, Hawaii.

Usually management wishes to know what the net return will be on a contemplated new investment. The chart shown above enables the engineer immediately to compute the net profit after taxes in terms of the compound interest rate which will be realized through the anticipated savings. The chart is based on the following relations:

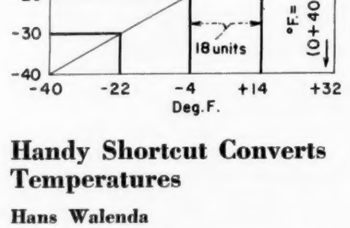
$$P = A[(1 + i)^{-1} + (1 + i)^{-2} + \cdots (1 + i)^{-n}]$$

$$A = s - (s - P/n)r$$

where P is first cost, A is annual saving after taxes, i is interest rate, n is years of service, s is annual saving before depreciation and taxes, and r is the tax rate, assumed at 50%.

As an example, if the total first cost of an additional turbogenerator is $750,000, the expected service life is 30 years, and the annual saving before taxes and depreciation is $50,000, what is the rate of return on the investment?

The dotted line on the chart shows a net return after taxes of 2.8% compound interest.



Handy Shortcut Converts Temperatures

Hans Walenda

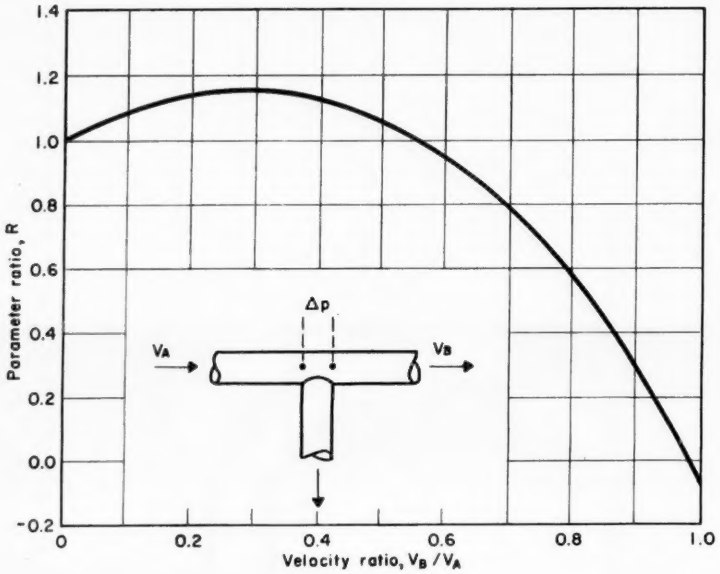
Engineer, Frankfurt am Main, Germany.

One of the easiest methods of mental conversion of Centigrade to Fahrenheit degrees, and vice versa, is based on the fact that −40 C. = −40 F. Starting from this point of equality, each ° C. change is matched by 1.8 F. change. (See chart.)

So, °C. = (°F. + 40) (5/9) −40, and °F. = (°C. + 40) (9/5) −40. Or, some may prefer to use as multipliers 0.555 + . . . (shown as 0.5*) for 5/9, and (2 −0.2) for (9/5), or

°C. = (°F. + 40)(0.5*) − 40
°F. = (°C. + 40)(2 − 0.2) − 40

Examples—Convert 486 F. to °C. First, add 40; 486 + 40 = 526. Then, 526 × 0.5* = 229.2*, and 292.2* −40 = 252.2*. Convert 165 C. to °F. First, 165 + 40 = 205. Then, (205 × 2) − (205 × 0.2) = 369, and 369 −40 = 329 F.



How to Find Pressure Gain Across Tees

R. R. Rothfus and H. G. McIlvried III

Chemical Engineering Dept., Carnegie Inst. of Technology, Pittsburgh, Pa.

The case of divergent flow through a 90° tee with the fluid entering the run is frequently encountered in piping installations and in headers or manifolds. Designers are often faced with the problem of estimating the pressure change along the run of a tee when a certain fraction of the fluid is removed through the sidearm. Here is a simple way to find the answer.

A mechanical energy balance on the fluid flowing through the run shows Δp to depend on the kinetic energy change and frictional effects. Since the conversion of kinetic energy to static head exceeds the friction loss under ordinary conditions, a gain in static pressure is realized. The net gain depends on the fluid density, the flow rates in the run and sidearm, and the roughness characteristics of the fitting.

It is convenient to express the pressure gain Δp across the run of the tee in terms of the dimensionless parameter $\Delta p g_o/\rho V^2_A$. For both smooth and standard screwed tees, the data of several investigators[1, 2, 3, 4] show that the pressure-change parameter is approximately parabolic in the velocity ratio V_B/V_A providing the fluid is essentially incompressible. That is,

$$\frac{\Delta p g_0}{\rho V^2_A} = \alpha + \beta\left(\frac{V_B}{V_A}\right) + \gamma\left(\frac{V_B}{V_A}\right)^2 \quad (1)$$

where α, β and γ are constants. It is apparent that α is the value of the pressure-change parameter when the tee is being used as an elbow. The values of the constants depend on the type of tee under consideration.

Available data indicate that Eq. (1) is virtually independent of the upstream Reynolds number in the turbulent flow range. Furthermore, since friction influences the pressure gain by a relatively small amount at most values of V_B/V_A, the maximum value of the pressure-change parameter occurs at about the same value of the velocity ratio regardless of the roughness of the tee or the diameters of its run and sidearm.

This suggests that $(\Delta p g_o/\rho V^2_A) \div \alpha$ might prove to be a unique function of V_B/V_A, and such is found to be the case when the experimental data are plotted in the proposed manner. The accompanying graph represents the best correlation of the available data. The average deviation of the experimental points from the indicated line is approximately 5% over the entire range of velocity ratio. The ordinate R of the graph is the ratio

$$R = \frac{(\Delta p g_0/\rho V^2_A)}{\alpha} = \frac{(\Delta p g_0/\rho V^2_A) \text{ at } V_B/V_A = V_B/V_A}{(\Delta p g_0/\rho V^2_A) \text{ at } V_B/V_A = 0} \quad (2)$$

The value of the pressure-change parameter at any fractional removal of the sidestream can be obtained from the plotted value of R, providing α is known. A single pressure measurement on the tee used as an elbow suffices to establish α. If such a measurement cannot be made, however, the accompanying table, based on the cited data, can be used at upstream Reynolds numbers between 3,000 and 150,000 for purposes of estimation:

Type of 90° Tee	α	Reference
Standard screwed iron	0.43	(2)
Smooth steel	0.39	(1)
Smooth copper and brass	0.33	(3, 4)

The supporting data cover upstream pipe diameters of 3/8 to 2 in., and sidearm diameters of 1/16 to 2 in. It appears that the results obtained on single tees are applicable to long manifolds, providing the take-off streams are several header diameters apart.

Nomenclature

- g_o — Conversion factor = 32.2 (lb. mass)(ft.)/(lb. force)(sec.^{2}).
- Δp — Increase in static pressure over straight run of tee, lb. force/sq.ft.
- R — Ratio of pressure-change parameters defined by Eq. (2), dimensionless.
- V_A — Bulk average fluid velocity in upstream leg of run, ft./sec.
- V_B — Bulk average fluid velocity in downstream leg of run, ft./sec.
- α, β, γ — Constants in Eq. (1).
- ρ — Fluid density, lb. mass/cu.ft.

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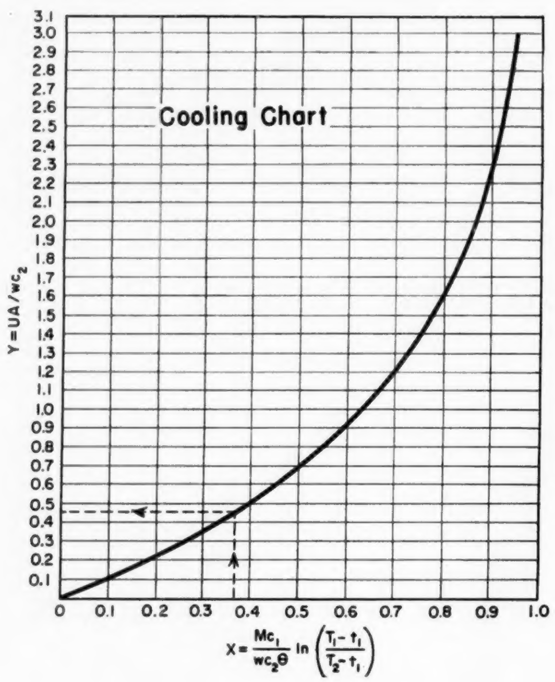

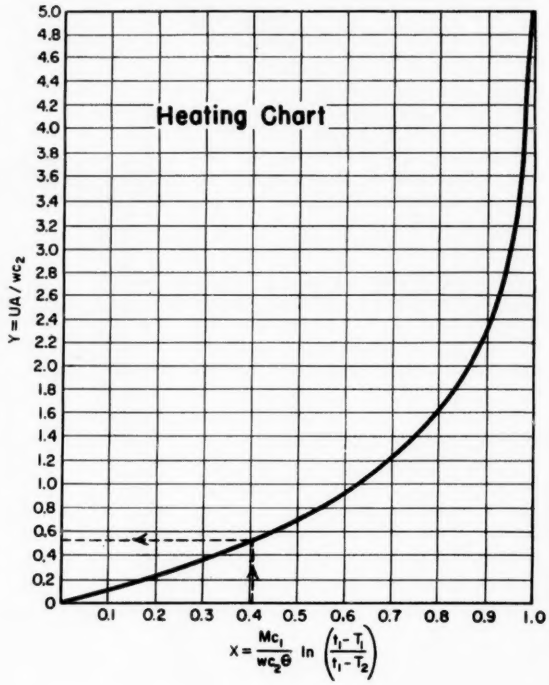

Graphs Solve Batch Heating and Cooling

H. A. Siekermann

Chemical Engineer, Overseas Eng. Dept., Proctor & Gamble Co., Cincinnati, Ohio.

The charts above offer a simplified method for solving unsteady state heat transfer problems for batchwise heating or cooling. They are based on equations developed by Chaddock and Sanders and published in AIChE *Transactions,* 40, 203 (1944). They can be used to find the heat transfer area in a coil or jacket required to accomplish a given amount of heating or cooling in a stated time in the case of a new installation. Or they can be used to find the over-all heat transfer coefficient in an existing installation by measuring the batch temperature and heating or cooling medium temperature at the start and finish of the operation, along with the time required.

The cooling chart shows the relation between the expressions:

$$X = \frac{Mc_1}{wc_2\theta} \ln\left(\frac{T_1 - t_1}{T_2 - t_1}\right)$$

and

$$Y = UA/wc_2$$

Similarly, the heating chart shows the relation between Y and:

$$X = \frac{Mc_1}{wc_2\theta} \ln\left(\frac{t_1 - T_1}{t_1 - T_2}\right)$$

Cooling Example—A seed tank of 4,800 gal. working capacity contains 4,800 gal. of mash (40,000 lb.) which is to be cooled from 220 F. to 86 F. in 4 hr. The cooling water flow is 100 gpm. (50,000 lb./hr.) and its inlet temperature is 60 F. Assume the over-all heat transfer coefficient is 50 Btu./(hr., sq. ft., °F.). How much area is required? First:

$$X = \left(\frac{40{,}000 \times 1}{50{,}000 \times 1 \times 4}\right) \times 2.3 \log\left(\frac{220 - 60}{86 - 60}\right) = 0.363$$

From the chart, $Y = UA/wc_2 = 0.45$, and $A = (0.45 \times 50{,}000 \times 1)/50 = 450$ sq. ft.

Heating Example—A tank of 9,000 gal. working capacity containing 9,000 gal. (75,000 lb.) of liquid of specific heat = 1.0, is to be heated from 70 F. to 150 F. with water in a coil or jacket at 180 F. entering temperature. Heating time is to be 3 hr. The heating medium flow rate is 80,000 lb./hr. Assume an overall heat transfer coefficient of 40 Btu./(hr., sq. ft., °F.). First, calculate X, then find Y from the chart, and calculate A from Y.

$$X = \left(\frac{75{,}000 \times 1}{80{,}000 \times 1 \times 3}\right) \times 2.3 \log\left(\frac{180 - 70}{180 - 150}\right) = 0.406$$

From the chart $Y = 0.53$, so $A = (0.53 \times 80{,}000 \times 1)/40 = 1{,}060$ sq. ft.

Nomenclature

- A Heat transfer area, sq. ft.
- c_1 Specific heat of material to be heated or cooled, Btu./(lb., °F.).
- c_2 Specific heat of heating or cooling medium, Btu./(lb., °F.).
- M Batch weight, lb.
- t_1 Inlet temperature of heating or cooling medium, °F.
- T_1 Initial batch temperature, °F.
- T_2 Final batch temperature, °F.
- w Flow rate of heating or cooling medium, lb./hr.
- θ Heating or cooling time, hr.

CE Flow File—I

Maxey Brooke, Chemical Engineer, Old Ocean, Tex.*

Author Brooke has assembled a collection of over 50 flow formulas from many sources, for use in his own working files. These formulas will appear in this location at the rate of four to six a month for about a year. Most of them are specific to certain fluids (e.g., water, air, steam), but some are more general. They will be presented in groups according to the particular fluid to which they apply. The groups to be covered, and the number of formulas in each (in parentheses) are as follows:

Water (16)
Liquids, general (7)
Petroleum and products (3)
Liquid suspensions (7)
Air (5)
Fuel and flue gases (5)
Steam (4)
Miscellaneous (8)

—EDITORS.

* Meet your author on p. 298.

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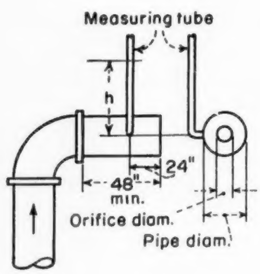
1. Water

APPLICATION

Flow of water through an open orifice to the atmosphere as shown.

FORMULA

$$Q = CA\sqrt{2gh}$$



NOMENCLATURE

Q = Water flow, gpm.
A = Orifice area, sq. in.
h = Height water rises in measuring tube above center of pipe, in.
g = 32.2 ft./sec.^{2}
C = Discharge coefficient as shown below.

$\dfrac{\text{Diameter orifice}}{\text{Diameter pipe}}$	C
0.3	0.552
0.4	0.563
0.5	0.583
0.6	0.613
0.7	0.660
0.8	0.740
0.85	0.810
0.87	0.850

REFERENCE

Layne and Bowler, Inc., advertising literature

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2. Water

APPLICATION

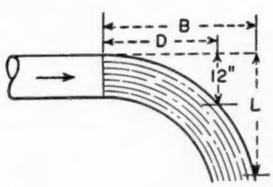
Flow of water from a horizontal open end pipe.

FORMULAS

$$Q = \frac{AD}{57.75}$$

$$q = 1.04AD$$

$$q = \frac{1.04AB}{\sqrt{L}}$$



NOMENCLATURE

Q = Flow, gps.
q = Flow, gpm.
A = Area of jet, sq. in.
D = Horizontal distance to point where vertical fall is 1 ft., in.
B = Horizontal distance to point where vertical fall is L ft., in.

REFERENCE

Calculated from the free-fall formula $x^2 = 2v^2y/g$. See *Industry & Power*, **54**, p. 85, May 1948

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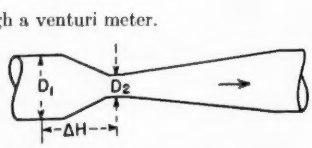
3. Water

APPLICATION

Flow of water through a venturi meter.



FORMULAS

$$Q = 440KA\sqrt{\Delta H}$$

$$K = \sqrt{\frac{2g}{1-(D_2/D_1)^4}}$$

NOMENCLATURE

Q = Flow, gpm.
A = Area at the throat, sq. ft., $= \pi D_2^2/4$.
$\Delta H = H_1 - H_2$
H_1 = Pressure at center of pipe at inlet section, ft. H_2O column.
H_2 = Pressure at throat, ft. H_2O column.
g = 32.2 ft./sec.^{2}
D_1 = Diameter of pipe at inlet section, ft.
D_2 = Diameter of throat, ft.

REFERENCE

API Manual on Disposal of Refinery Wastes, 4th ed., p.67 (1949).

PRACTICE . . .

CORROSION FORUM

EDITED BY R. B. NORDEN

Latest Corrosion Data on Zirconium

Reagent	Concentration % by Weight	Temp. C.	Rating
Acetic acid	5, 99.5	60, 100	A
Aluminum chloride	20, 30	Room-boiling	A
Ammonium hydroxide	28	Room-100	A
Aqua regia		18-60	C
Calcium chloride	20, 30, 50	20, 49, 100	A
Carbon tetrachloride	100	Room-49	A
Chlorine saturated H_2O		Room	A
H_2O saturated Cl_2		Room	C
Citric acid	10	Room-100	A
Cupric chloride	1-25	35	C
Chromic acid	10, 20, 30	20, 49, 100	A
Ethyl alcohol	95	Boiling	A
Ferric chloride	2.5-30%	18-100	C
Formic acid	90	20, 49-boiling	A
Hydrochloric acid	Dilute	All temp.	A
	Conc.	Room	A
	Conc.	Boiling	C
Hydrogen peroxide	10	49	A
Mercuric chloride	1% saturated	35-100	A
Methyl alcohol	99	Boiling	A
Monochloracetic acid	100	Boiling	A
Nitric acid	10%	18-100	A
White fuming HNO_3		Room-71	B
Red fuming HNO_3		Room-71	C
Oxalic acid	1-25	100	A
Phenol	25, 50, 100	20, 49-boiling	A
Potassium hydroxide	10, 20, 30, 40	Room-100	A
Phosphoric acid	10-85	Room-10	A to B
Sodium chloride	3	35	A
Sodium hydroxide	10, 50	Room-100	A
Sulfuric acid	10	18-100	A
	96	100	C
Tartaric acid	10, 25, 50	20, 49-boiling	A

*An "A" rating means corrosion of not more than 5 mils penetration per year (mpy.) A "B" rating implies rates of 5 to 10 mpy. A "C" rating indicates more than 10 mpy.

More Zirconium Coming for Process Equipment

Corrosion-resistant zirconium can be machined to produce chemical equipment. Substantial quantities of the metal will soon become available.

With the announcement of the AEC 11-million lb., five-yr. program, much attention has been focused recently on the corrosion resistant and physical properties of zirconium metal.

Three companies* have been awarded contracts under the program. Two will produce zirconium via the Kroll process (magnesium reduction of zirconium tetrachloride), the third will make zirconium using a sodium reduction method.

The program calls for a high-purity, atomic reactor-grade material. But the new plants under construction will make quantities of a cheaper, commercial-grade containing 1-3% hafnium.

One producer claims it can eventually make commercial sponge zirconium at $3.50/lb., and finished fabricated parts will be priced at about $15/lb.

Pure zirconium is practically transparent to low-speed neutrons and as a result it is used widely as a corrosion-resistant material of construction for atomic reactors.

However, the commercial grade has some very interesting properties similar to the pure metal. It is lightweight with good tensile properties, and should find a number of applications in the chemical industry.

*The companies involved are: National Distillers, Carborundum Metals and National Research.

Good Tensile Strength

Its tensile strength is in the titanium range of 50,000 psi. Zirconium tends to lose some of its strength at high temperatures (11,000 psi. at 500 C.) and does not compare favorably with stainless in this respect.

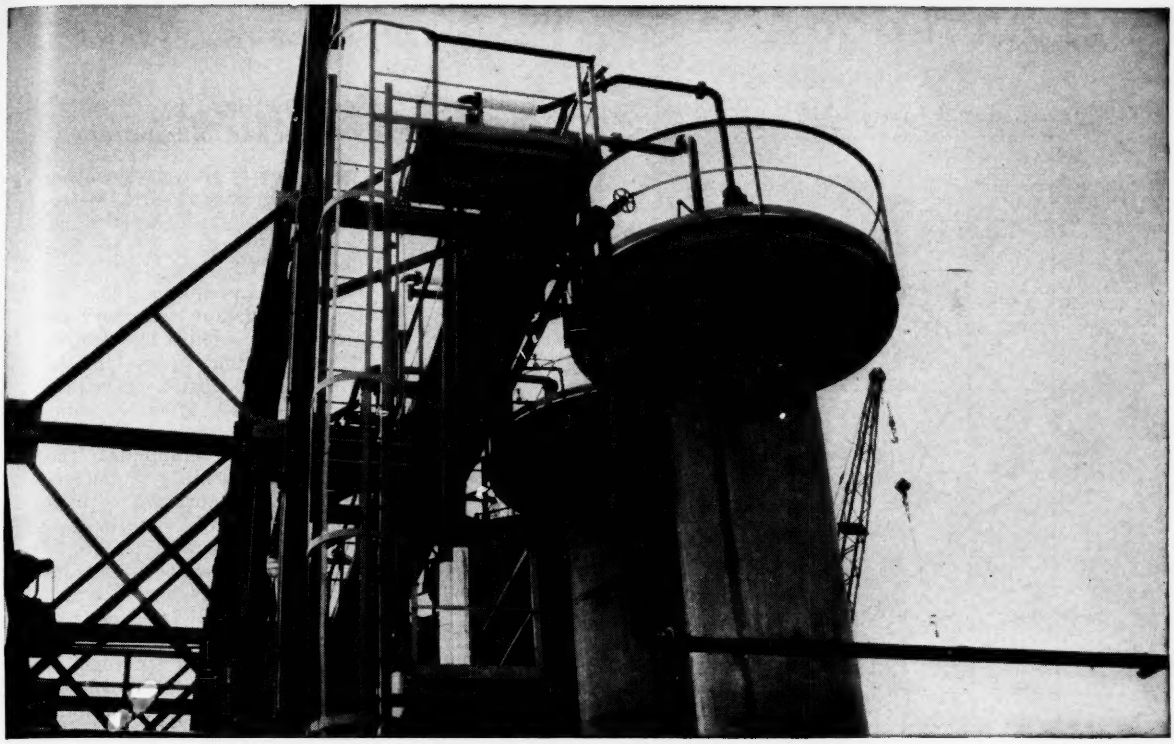
Cold working, however, improves the tensile properties of zirconium. Over 90% of the increase in hardness and strength due to work hardening occurs at 0 to 10% cold work.

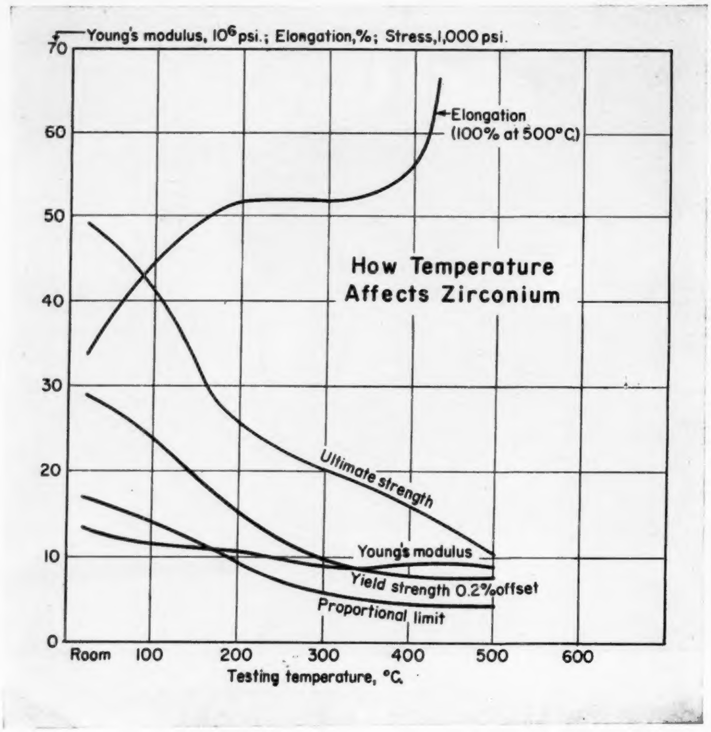
Zirconium reacts with atmospheric gases, and must be welded under an inert blanket of argon or helium.

Resists Corrosion

One of the outstanding properties of zirconium is its resistance to many chemicals (see table).

In particular zirconium is superior to titanium for dilute, boiling hydrochloric acid, con-





centrated phosphoric acid and oxalic acid.

Zirconium is almost completely resistant to organic acids such as formic, acetic, monochloroacetic, dichloroacetic, trichloroacetic, lactic, tannic, oxalic, tartaric and citric at room temperature.

And it is completely resistant to a 95% solution of hydrazine at room temperature. Also, zirconium is completely resistant to substitute ocean water at 35 C.

Making Chemical Equipment

The machinability of zirconium is close to that of titanium and stainless. It can be machined on equipment designed for stainless steel.

A list of equipment successfully made out of zirconium at the Bureau of Mines in Albany, Oregon, include: Zirconium-lined tank, steam-jet exhauster, agitator hub, exhaust fan, mechanical seals, globe valves, spray nozzles, water aspirator, rotary filter valves, pump parts.

Important Physical Properties for Kroll Zirconium

Density (26C.)	6.5 gm./cc.
Melting pt	1,860 C.
Boiling pt	over 2,900 C.
Coefficient of thermal expansion	4.9×10^{-6}/C.
Thermal conductivity	0.040 cal./C./cm./sec.
Thermal capacity, Cp, (25-100C.)	0.069 cal./gm./C.
Resistivity	39.7 micohm-cm. (20 C.)
Hardness	Brinell 125-145
Tensile strength	50,000 psi.
Yield strength	30,000 psi. (0.2% offset)
Young's modulus	13.5×10^6 psi.
Elongation in 2 in	34% (annealed sheet)

New Coating Process for Magnesium

A new protective-coating process for magnesium, developed by Dow Chemical, is in use at Ryan Aeronautical in San Diego, Calif.

Coating produced is an abrasion-resistant refractory ceramic. It's applied by electrolytic action, and is insoluble in water, resists alkaline solutions and some dilute acids. It withstands temperatures to 650 C.

The process eliminates the need for pre-pickling in dangerous HF, and abrasive or mechanical cleaning operations.

First the magnesium parts to be treated are suspended from magnesium hangers, which are equally distributed along two bus bars (heavy copper conductors). Alternating current is used—only half the load in anodic at one time. Magnesium worked out better than aluminum or steel for the hangers—the bath attacks aluminum, and steel draws too much current.

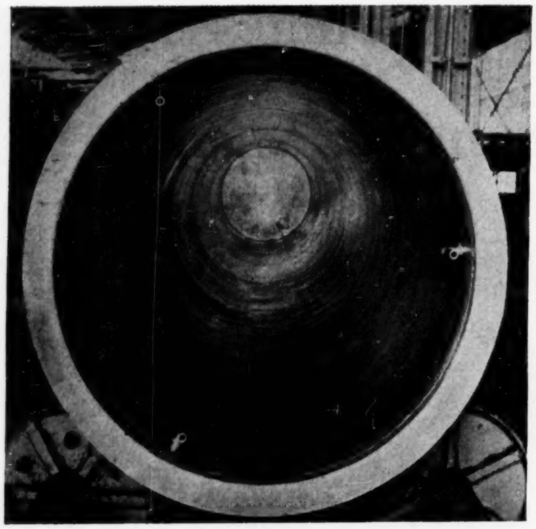
Next an overhead crane lowers the parts into a tank of heavy-duty alkaline cleaner (sodium hydroxide) to remove any oil film. This is followed by a five minute rinse in warm running water.

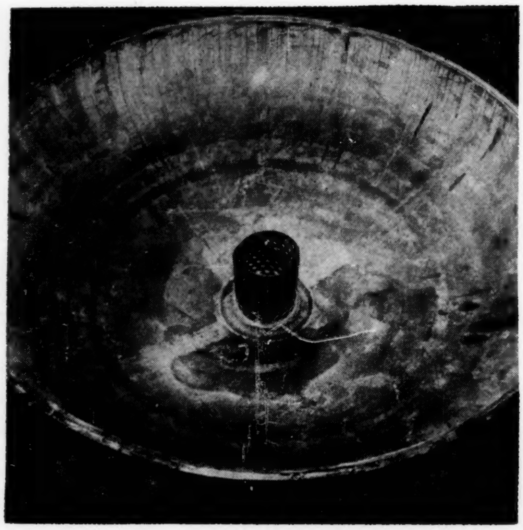
Parts are then immersed in a tank containing a solution of the ceramic (Dow No. 17). About 20 amp./sq.ft. of surface is applied, although this is an alternating current operation and the total surface is divided by two.

Voltage regulation is automatic—as the coating builds up, electrical resistance increases. Voltage increases to maintain a constant amperage until a set voltage (70 volts for sheet stock) is reached. Then the equipment shuts off.

Anodizing requires about five minutes tank time. After leaving the bath parts are rinsed in cold running water for five minutes, then oven dried or blown dry with compressed air.

Coating is approximately 0.0002 in. thick and varies in appearance depending on the base metal. Sheet stock exhibits a smooth cream color, while casting are dark green. The coatings are non-conductive.





NEW VACUUM TECHNIQUE bonds silver to stainless; stainless to carbon steel. (Chicago Bridge and Iron)

Cladding Handles Severe Conditions

A fine-silver cladding is proving effective against urea solutions. This new vacuum method promises to solve the problem of cladding with zirconium and tantalum.

Vacuum-brazed cladding is attracting much attention these days for corrosion-resistant service.

This cladding is produced by a flux-free, high-vacuum brazing process rather than the mechanical rolling method. Among the cladding materials successfully brazed to low and medium carbon steel are stainless steels (both chromium and chromium-nickel), nickel, and high-nickel alloys such as Monel, Inconel and Hastelloy B and F.

Vacuum Brazing Advantages

Uniform thickness of the cladding layer is the primary advantage high-vacuum brazing seems to offer in the manufacture of high-strength, continuously clad alloy plate.

Vacuum-brazing the clad material to the backing plate results in a high-strength bond and has little effect on thickness of the clad or backing material. Thickness tolerances are governed only by the as-rolled alloy sheet or backing plate used in the process. Uniform thickness of backing material is advantageous when the clad material is considerably weaker than the backing material.

A second advantage claimed for flux-free vacuum brazing is its adaptability to the manufacture of most sizes or shapes of flat-clad plate that can be readily fabricated into the usual shapes of tanks, pressure vessels.

Finished clad surfaces are bright and free from contamination. Their surface finish is identical with that of the alloy sheet itself before brazing.

Physical properties of clad vessels exceed code requirements as established by the ASME Boiler and Pressure Vessel Code and the API-ASME Unfired Pressure Vessel Code for composite materials. Physical properties of clad plates also are well above the requirements of ASTM for integrally and continuously clad materials as shown in materials specifications A-263, A-264 and A-265.

Tensile strengths of the finished vacuum-brazed plates are within specified requirements for each particular cladding metal combination. Control of bonding and heat treating provides high bond strengths with good ductility, formability, and corrosion resistance.

In testing the ductility and bond strengths of clad plate, test specimens are bent with the clad layer in both tension and compression, (on both the outside and inside of 180° bends). Most types of vacuum-bonded clad plate successfully withstand this severe test of bending test specimens down flat on themselves. The bond between the alloy clad and the base metal is capable of withstanding high strains with the alloy either in tension or in compression.

Shear strengths of vacuum-brazed plate depend on the types of metals being joined and range as high as 60,000 psi, with the average around 40,000 psi. These strengths are high enough for all ordinary operations encountered in pressure-vessel fabrication.

Vacuum-brazed materials are

you can

CUT YOUR MAINTENANCE PAINTING COSTS UP TO 50% *with* AMERCOAT 87 VINYL MASTIC

HERE IS HOW THIS REMARKABLE PROTECTIVE COATING CAN SAVE YOU MONEY:

1. Only one cross spray coat over a primed surface is required for complete protection—this means lower labor costs.

2. Fewer scaffolding and rigging shifts are required.

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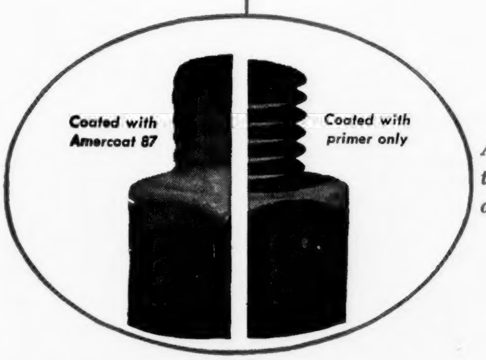
4. Greater thickness means longer life—lower cost per square foot per year.



Amercoat 87's thixotropic characteristic helps provide extra thickness on sharp edges and irregular surfaces; it is non-porous and will not crack or check.

Amercoat 87 combines the time-tested chemical and weather resistance of vinyl coatings with the thickness of conventional mastics, yet is easily applied with standard industrial spray equipment.

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welded by the usual welding techniques developed for clad plate. Fittings and internal equipment can be welded directly to the integrally bonded clad surface.

Cladding Techniques

The high-strength vacuum-brazing process differs from conventional furnace brazing in that it requires neither fluxes nor special furnace atmospheres to obtain sound joints. Fluxes are difficult to remove from large surface areas and their presence in the bond zone after brazing can cause voids in the bond, brittle areas, and low bond strengths.

The vacuum process, applicable to large areas bonds the clad and backing materials with alloys of copper, nickel, iron, silver or any of several proprietary alloys, depending on the service requirement of the composite plate. Brazing materials may be applied as foil, powder, or in several other forms.

Brazing is done under a high interior vacuum, which causes atmospheric pressure to exert a large uniformly distributed force over the entire brazing area. This produces a continuous and uniform bond with a thin layer of brazing alloy. High bond strengths are obtained through alloying at the brazing interface.

The combination of high interior vacuum and high temperatures during the bonding cycle also causes breakdown of oxide films on the bonding surfaces of some types of metals, promoting the formation of strong, uniform bonds. Oxidizing gases evolved as products of these reactions and by outgassing of the metals being joined are immediately removed from the bonding interfaces by the high vacuum condition existing in these areas; reoxidation of bonding surfaces doesn't occur.

Corrosion Service

In the petroleum industry, vacuum claddings have held up under varied conditions of corrosion and service at temperatures up to 1000F. Vessels have been in service since 1951, with no marked indications of corrosive attack. Examples in service in the petroleum industry are chromium, chromium-nickel and Monel claddings in several large reactors, crude towers, fractionators, coking chambers, vacuum towers, atmospheric tower distillate drums, oily condensate drums and combination towers.

The chemical industry, with extremely corrosive applications, has placed several large vessels of fine silver clad on chromium-nickel stainless steel in urea service. Another special application is Hastelloy B clad on carbon steel, which is being used for urea service and in alkylator units.

In the pulp and paper industries, chromium-nickel-molybdenum stainless and Inconel claddings have proved highly corrosion-resistant. They are being used in digesters and replacement sections at the more corrosive liquid-level area.

Digester service is especially corrosive because of variations in cooking liquor compositions and increasing rates of chemical treatment. For such service, corrosion-resistant alloy claddings permit the use of better processing methods, including higher temperatures, concentrations, and pressures without the high costs of solid alloy vessels.

Complete digesters and replacement digester sections with stainless cladding now in service are being inspected periodically to determine corrosion resistance under these severe conditions. To date no adverse corrosive action has been observed. An Inconel clad ring was installed at the liquid-vapor level in a paper pulp digester for observation. This ring replaced one in which severe corrosion and pitting has occurred.

This Inconel clad ring has been in service over four years. Periodic examinations have been made, and upon last inspection no pitting has been found and general corrosion has been observed only as light etching of the clad surface.

Future Applications

Vacuum-bonded clad materials are being fabricated into a wide variety of pressure and storage vessels. Shop fabrication does not limit the type or size of vessels that can be supplied as brazed cladding holds up under most shop fabrication techniques—rolling, bending and welding. It can also be formed into flanged and dished ellipsoidal and hemispherical heads for tanks and pressure vessels.

The full potential of this versatile vacuum bonding process probably hasn't been completely realized. New and practical methods of cladding high-temperature metals such as titanium, zirconium, tantalum, molybdenum and other metals are under development. Other cladding methods have failed with those metals because of their high sensitivity to gaseous embrittlement at bonding temperatures and their resistance to deformation at elevated temperatures.

The process is under consideration also for cladding of precious metals such as gold and platinum to dissimilar metals. Several large fine silver vessels (clad on stainless steels) are in service under highly corrosive applications in the chemical industry.

Metals such as copper, cupronickels, aluminum bronze, and numerous others hold promise for the vacuum bonding process on vessels and containers for the food-processing and brewing industries. Abrasion-resistant claddings are also under development for specialized uses.

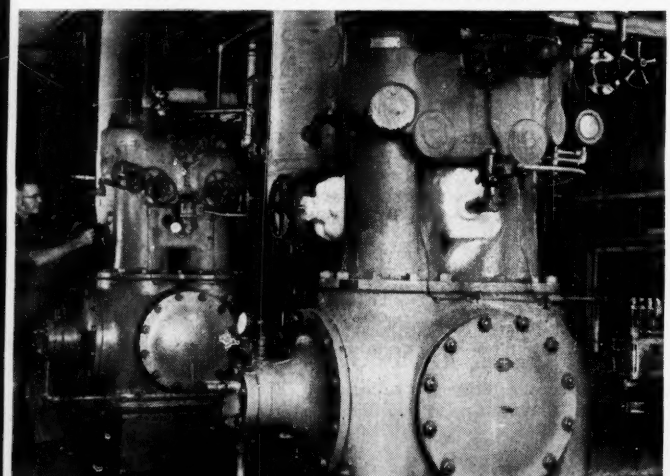
NEXT MONTH

CORROSION AT TUSCOLA

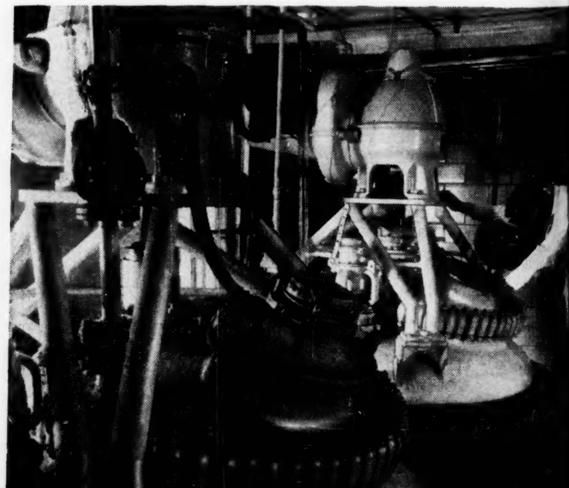
A number of unexpected corrosion problems developed during operation of National Petro-Chemicals' plant at Tuscola, Ill. —carbon steel corroded when handling cold 92% H_2SO_4; high-alloy steels were unsatisfactory for 45% H_2SO_4; copper pipe failed in contact with sulfuric vapors; Monel corroded when handling hydrocarbon vapors. In the February Corrosion Forum Doug Gardner will show how these problems were analyzed and solved.

SPIDER WEB in piping reaches far ends of a refrigeration system supplying more than 25 buildings at MERCK & CO. Inc.'s Rahway, N. J. plant.

BACKBONE OF CENTRAL SYSTEM is two 75-ton York compressors. Here, ammonia is piped to remotely located brine tanks and attendant coolers where refrigerant is used in processing fine chemicals.



PRECISE TEMPERATURE CONTROL (to 0°C), supplied by York equipment proves vital for purification of an important vitamin product.



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Chemical Engineering

People

JANUARY 1957

Department Index

Jobs Abound, But Competition Increases

If you want to change jobs this year, you won't have much trouble finding a new one. But for good posts, the competition is fierce.

ASSUMING that today's indicators hold up, 1957 will be a kind year to chemical engineers who are either starting or making a change in their career. Both job-seekers and job-changers will find an abundance of positions open.

Chemical process industries* are planning to spend something like $4¼ billion on the coming year's expansions and like sums in succeeding years, and defense spending is slated to remain at a high level. So jobs available will easily blot up the 1,200 or so new graduates left to industry after ROTC programs, reserve enlistments, the draft and graduate schools levy their tax on the slightly-over-2,700 new chemical engineers due to graduate in the coming months.

The 1,000-1,500 ChE's now in the services who'll pick up their discharge papers in '57 will also be eagerly sought after by engineer-hungry chemical firms. Indeed, several companies are keeping recruiters stationed at service discharge points on a permanent or semipermanent basis.

But, while there'll still be openings remaining for more experienced engineers, applicants can look for plenty of competition when they try to fill them.

Perhaps this competition is a sign that industry has yet to learn how to keep its professional people happy on the job and that there is a high percentage of dissatisfied men in engineering work; or maybe it just signifies a surge of restlessness among engineers, likely brought on by tales of an engineer shortage and high salaries and interesting work just around the corporate corner; or maybe it's just that the people who write the copy for help wanted ads are doing an extremely competent job.

But whatever it means, this competition is real and it's important to you if you're job-hunting. Here's what you're up against.

- A fair-sized eastern chemical maker recently advertised for two men with chemical engineering training and experience in market research to fill posts of high responsibility. It received over 100 replies. But only eight came close to having the needed qualifications.
- Ads placed by one of the larger firms told of eight openings. They drew upwards of 300 applicants—many from outside of the United States—barely 20 could meet the job requirements.
- One of the most fantastic stories is being told by a small company that needed a plant manager. Its series of ads—each stressing the qualifications desired: 15-20 years of experience, a record of successful administrative work and so on—sparked nearly 500 replies. Applying for this $25,000/yr. post were engineers with as little as three years in industry, production foreman with no engineering training, even a few salesmen. Some 95% of the applications were weeded out at the first glance.

"Apparently," one personnel manager told *Chemical Engineering*, "many engineers send in their resumes on the basis of what they would like to have in a job with little regard for what they can actually do. In addition, a few go to great lengths to draw the reviewers attention to their resume. But, of course, much of this competition is competition in name only. When you need a man with a particular background, 1,000 applications from men who don't have that background mean nothing—you haven't filled your opening."

But it does mean something to the engineer applying for the position. For one thing, it means that the law of supply and demand cannot operate as effectively as it might. Few men will change jobs without getting some sort of a salary boost for their troubles. But with this sort of competition one can easily find cases in which a company took a less qualified man instead of paying a higher price for the best qualified man. This is particularly true if the best qualified is over 45.

For instance, a spokesman for a St. Louis job agency contends that "we can get as much as $525/mo. for a young engineer right out of college, but we can't place engineers with 15 years experience for $600/mo."

As a class, job-hunting engineers past 50 always have the most trouble. Exceptions are those with a good deal of management experience and those with established reputations in a specialty.

In the coming months, added competition may come from foreign-trained engineers. In 1956, General Electric started advertising in a newspaper in Turin, Italy, for men to fill posts at the company's aircraft gas turbine division in Cincinnati. Other firms are reported farming out both engineering and research projects to foreign-based companies.

In general, then, in 1957 there will be plenty of jobs available—probably more than in any recent year. Inexperienced men will continue in heaviest demand, but you'll see more and more ads asking for men with 3-10 years experience.

* Including chemicals, paper, rubber, petroleum refining and stone, glass and clay industries.

Job turnover also appears to be on the rise. This will mean more openings, but it also means more competition for the better positions.

Here's how the situation looks for each job catagory.

In Research

Smart new graduates can practically write their own ticket. Older men can find openings, too, but only in certain specialties. Salaries are climbing. Quality keys hiring.

"You have to be good to make money in research work." That's how one research director summed up his company's stress on quality in hiring new researchers.

As in years past, a relatively recent graduate with a high academic rating, a young fellow with a graduate degree or two and older specialists with a solid record of research achievement to exhibit have little trouble lining up a spot. Specialists in polymer, ceramic, metallurgical and nuclear research are in greatest demand.

Salaries appear to be on the rise—but not as fast as most job seekers would like. This is giving those concerned with hiring their biggest headaches.

Let one who's recently been in the market for several top-level research men sum it up: "It's easy to get people, but it's difficult to get people who can meet your requirements and who ask a price you can afford to pay. When you do come on a qualified man you find that the equity he's built up in his present job pushes his price way out of line. An $11,000/yr. man wants $15,000/yr. to make a change to a job that's worth maybe $12,000/yr. to us."

Quality is all-important to most companies. They point out that in research sheer numbers of workers means very little. The abilities of the researchers mean a great deal. (Sometimes, emphasis on quality is carried to ridiculous lengths: One large chemical maker recently advertised for "Top scientists with 0 to 5 years experience.")

Freshly minted PhD's are the prime targets for industry's talent scouts. They'll use offers of $7,000/yr. and up to bag their quarry in the coming months.

A BS straight from a school will be able to command $425-450/mo. to start. A fellow who's completed his required military service will usually be offered $20-$25/mo. more.

Despite industry efforts to ease the pain of those engineers caught in the salary squeeze that these high starting rates have caused, salary inequities still exist. Many employers appear to find it easier to pay the tolls of high turnover than to revise their entire salary schedule for engineering talent.

In Development

Youth is served first, but men with five to ten years experience can find openings.

Perhaps it's because the pilot-sized units used resemble those in the unit operations lab at college and make them feel at home, or maybe they and their companies feel that they can learn more and contribute more in this type of activity, but whatever it is, a large percentage of new graduates take their BS's into development work.

Therefore, lack of an adequate supply of graduates has opened opportunities to engineers with several years experience in other lines. Over the past few years this has led to some pirating, especially on the part of smaller companies, but there is relatively little of this now.

Of course, what you mean by "pirating" depends on whether you're the one that's gaining the man or the one losing him. To one chief engineer a man has been pirated when another company makes him a offer and he accepts—even though it was the man and not the company that made the first contact. Generally, however, it's pirating when a firm approaches an already-employed engineer with a job offer, without any prior display of interest on the engineer's part.

What piracy of development engineers there is is usually blamed on the smaller companies. Often left holding the bag in college recruiting, smaller firms say that they have no choice but to make offers to experienced men. Such offers, however, are usually limited to engineers with from five to ten years experience. Only a sorely needed specialist or a potential manager will tempt companies, big or small, to relax these limits.

The emphasis on youth in development work has helped push the salary scale up faster than for other types of activity.

In Process Design

Experienced men are in demand. Salaries seem to have stabilized. But look for the rise to resume in '57.

Those billion-dollar expansion plans mentioned earlier will likely bring a renewed demand for engineering manpower in process design work in the months ahead.

Right now, salaries appear to have stabilized, but they probably won't stay that way long. A prominent engineering-design firm says that it hasn't had to revise its salary schedule in well over a year. But it does expect to make an upward revision sometime in the next few months to meet industry competition for trained men and to hold on to those it now has.

There has always been some pirating going on among the engineering outfits and between these firms and their clients. But while this activity has been relatively quiet recently, many observers expect it to flare up in the coming months, particularly in the East. On the West Coast, where piracy was most prevalent in '56, it is expected to be an even greater problem for company management.

Atomic energy work is also putting a drain on the supply of experienced, capable design personnel. Those charged with hiring such people say that pirating is about the only way they can lay their hands on first-rate men. Trade shows and conventions are the "Spanish Main" of the personnel pirates. One firm admits that it now keeps a re-

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cruiter in its exhibition booth along with the usual salesmen.

But don't be fooled by these extensive recruiting efforts into thinking that just about anybody can get a job in this line. Engineering firms are nearly unanimous in saying that they can't afford to hire second-rate engineers. From bitter past experience many have found that it's better to pass up a job from a client than to staff it with any but top-quality people.

Those in charge of hiring say that it's fairly easy to get applicants, but difficult to find applicants with the proper background and experience (and where have we heard that before?).

Companies are also putting considerable emphasis on the personal characteristics of applicants, in addition to studying their training and work record. Says the personnel director of a prominent firm: "We expect the people we hire to be able to work harmoniously with our other employees and with those of our clients. A few 'foul balls' can lose a lot of ball games for us." Others echo his sentiments.

In Production

Salaries are relatively static and hiring problems are growing. Firms stress job satisfaction and management responsibilities.

Stepchild place in the recruiter's efforts appears to have been assigned to production work.

Demands that other activities make on the manpower supply, the relatively low salary scale and spartan-like working conditions associated with work in production make this activity less attractive than others to today's graduates.

More and more companies are using men with development experience and management potential to fill these spots. Operating personnel and men with degrees in chemistry are also being trained for production jobs.

A young engineer interested in production work will find little trouble in getting a job. Even the older engineer can locate openings. But salaries are relatively low—except for high-level positions—when compared with other types of work.

In Marketing

Opportunities in market research and sales engineering are many and relatively well paying.

Engineers with the proper blend of technical and business training and experience can find openings in the selling end of the chemical industry without trouble.

Creating customers is now about as big a job as creating products. Although relatively new to the industry, market research techniques are now a vital part of the marketing effort of nearly all chemical companies. And men who can use these techniques are avidly sought.

In other phases of chemical marketing, too—product development, sales engineering and technical service—there is a growing demand for engineers with business aptitudes.

For the engineer, who can qualify, this work is relatively well paid, and quite often it is a good route on which to climb the corporate ladder. Requiring men with both a technical background and business experience, chemical marketing seems to be a likely training ground for future industry executives.

In Management

Demand for good men is high, but landing a job isn't easy. Compensation is rising steadily.

"In the coming year we'll need about four high-level executives in addition to our present corps to run the expansions on our books." That statement from a chemical company's executive vice president just about sums up the industry's need for managerial talent.

Today's expansion-created openings put a strain on old-fashioned methods of executive development and account in part for industry's turning to planned programs of development. These help fit more engineers for management posts. but by developing a home-grown management, they also restrict opportunities for job-hunting executives. So while executive-level jobs are always available, is may not be too easy to locate the one you're looking for.

The people who specialize in finding men to fill these jobs report that requests from the chemical industry increasingly call for men with technical training. But invariably they also want a background that includes administrative experience.

These posts are pretty well paid. Salaries for top-level chemical industry executives are running a bit above the all-industry average. Stock options, bonus plans and other forms of compensation are now quite common.

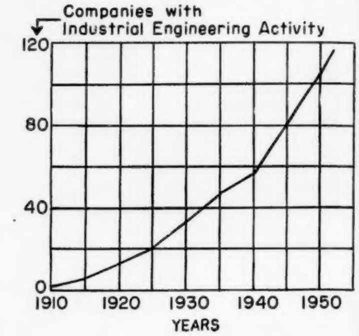
Though the Over-45 Club of New York, which helps its members find jobs, usually of a managerial type, recently reported that for the first time its list of jobs available was greater than its roster of job-seeking members, men past 45 still have a relatively difficult time securing worthwhile employment. Companies are reluctant to bring in an outsider who can only serve them for a relatively short time before going on pension. An impressive background of successful managerial experience is the job seekers' only defense against this attitude.

Next Month: How to Cultivate Executive Potential

With more and more companies looking to their engineers for their supply of future executive talent and a bewildering array of executive training programs in use, it's easy for supervisors to lose sight of the fact that executive development begins in the department. Next month, You & Your Job will offer a few simple, easy-to-use suggestions that supervisors and middle-management can use to stimulate the development of executive potential in their subordinate engineers. Not a personnel-department type of program, these suggestions can be fitted right in to your group's daily operations.

PEOPLE . . .

TECHNICAL



Now an I. E. Handbook

INDUSTRIAL ENGINEERING HANDBOOK. H. B. Maynard, Editor-in-Chief. McGraw-Hill Book Co., New York. 1,504 pages. $17.50.

Industrial engineering has been defined as the engineering approach applied to all factors, including the human factor, involved in the production and distribution of products or services.

If we accept this definition—and we most certainly can not—then we would be forced to conclude that there is no place in our society for civil, electrical, mechanical, mining or chemical engineers. (Perish the thought!) Under the terms of this definition, we are really all industrial engineers.

Certainly this is not the case, and industrial engineers themselves would be the first to admit that they do not intend to carve out the whole of engineering as their slice of the pie.

What *is* industrial engineering, then?

Industrial engineering as a profession is a relative "boy in short pants" in the engineering world. But it's a boy that's growing fast and learning quickly (see chart above).

We can trace the birth of industrial engineering in America to some of the pioneers of scientific management. The critical years were 1882 to 1912 and some of the important names were Lawrence Gantt, Frederick Winslow Taylor, Frank and Lillian Gilbreth, Harrington

BOOKSHELF

EDITED BY R. K. GITLIN

Emerson and Mary Parker Follett.*

To these Americans, we should add the names of Henri Fayol of France and Lyndall Urwick of England.

Originally the advocates of scientific management found their podiums at meetings of ASME. The management division of ASME still is a stronghold of industrial engineering thought today. However, it seems reasonable to assume that the American Institute of Industrial Engineers, now less than ten years old, will become the focal point for industrial engineering science.

As a benchmark for comparison, consider that AIChE is preparing to celebrate its 50th anniversary and that the 4th edition of the "Chemical Engineers' Handbook" is now in the planning stage.

It is against this background that we get to the business at hand. Why should you, as a chemical engineer, be interested in this first edition of the "Industrial Engineering Handbook"?

The first good reason we can think of is if you work for a company that has an industrial engineering department somewhere within its organization structure. In your industrial intercourse with these new creatures called industrial engineers, you'll want to know something about what they're made of and what they can do. The "Industrial Engineering Handbook" tells how they do it.

The second reason is that you can sometimes borrow the tools of other engineers to help solve chemical engineering problems. Here, then, is another valuable reference volume for you to use. Perhaps you may find answers to some of your engineering problems in the following sections of this handbook:

* It is worth noting that at New York University, which has the largest enrollment of industrial engineering students in the U. S., the faculty has established Mary Parker Follett as one of the great philosophers in the field of management. However, this handbook doesn't list Mary Follett in its index.

Methods; Work Measurement; Time Standards; Wage Payment; Control Procedures; Plant Facilities and Design.

You might be one of only a few engineers in your plant, if not the only one. Then you can profit from every engineering tool that's available. Here's another set of tools, conveniently bound together in a single volume.

Another reason for recommending this book is that there's some darn fine engineering reading in it. We especially enjoyed perusing the following six chapters:

- Curves and Nomographs by R. P. Hoelscher.
- Cost-Reduction Procedures by Walter Scott.
- Personnel Testing by E. J. McCormick.
- Operations Research by R. O. Ferguson and Morley Melden.
- Nonindustrial Applications of Industrial Engineering by Dr. Lillian Gilbreth.
- The Fundamentals of Automation by Harry Waddell.

But we reserve our highest recommendation for two chapters that we think ought to be included in every single engineering handbook. They are:

- Preparation of Effective Reports by Rudolph Flesch.
- Graphical Presentation Methods by George Dusenbury.

Flesch is now the center of controversy because of his recent best-seller, "Why Johnny Can't Read." He is especially exciting when he explains why engineers can't write.

George Dusenbury is a renowned authority on magazine design and the problems associated with serving up technical information on palatable platters. Every engineer, no matter what his branch of engineering, can benefit from what Dusenbury has to say about the presentation of technical information.

It will be difficult for a chemical engineer to justify a $17.50 expenditure to add this handbook to his personal bookshelf. However, the chemical engineer who has access to this book and is familiar with its contents will be one up on his brethren.—RFF

Tribute to a Scientist

PERSPECTIVES IN ORGANIC CHEMISTRY. By Sir Alexander Todd. Interscience Publishers, New York. 537 pages. $7.50.

Reviewed by F. C. Nachod.

As a tribute to a great living scientist, Sir Robert Robinson, 18 outstanding fellow chemists from the U. S., Great Britain, Germany and Sweden have written lucid essays in which they report on their fields of specialization.

The list of contributors reads like "Who's Who in Chemistry." The essays make for fascinating studying even if the reader has but a slight acquaintance with the particular subject matter but the ambition for catholic breadth of knowledge which characterizes the man to whom the "Festschrift" is dedicated.

Population Boom

SCIENCE AND ECONOMIC DEVELOPMENT. By Richard L. Meier. Technology Press (M.I.T.) and John Wiley & Sons, New York. 266 pages. $6.

If our 34th Annual Review, "Population Boom Challenges Chemical Technology" (pp. 211-226), stimulated your interest in what's ahead for the scientist and engineer, you might want to explore the subject further with this new book as your guide.

Although plans for our review were well along when Meier's book hit our desk, we had time to crib a few of his figures, for which we are pleased to give credit herewith.

The scope of Meier's book is much broader, of course, than that of our review. Skeptics might criticize the book as being visionary or fanciful. For the most part we found it to be technologically sound, albeit uninhibited, in its approach to the solution of mankind's economic problems.

Meier discusses our future needs in terms of new foods, new fuels and new patterns of living. He puts great store in the culture of algae to provide not only food, but also power and liquid fuels, for an expand-

ing world population. He points up a basic obstacle to economic improvement—the difficulty of out-producing present growing world needs in order to provide capital facilities for meeting future needs.

Meier devotes about ten pages to an approach outside the scope of our review—more widespread use of present or yet-to-be-developed methods of birth control. "All further elaboration of a new strategy for economic development rests upon the premise that some such solution will be found for an important share of underdeveloped areas."—CHC

The First Family

COMPREHENSIVE INORGANIC CHEMISTRY. Vol. V. Edited by M. C. Sneed and R. C. Brasted. D. Van Nostrand Co., Princeton, N. J. 214 pages. $5.

Reviewed by K. A. Kobe

"The importance of the chemistry of the nitrogen family of the elements—from both the practical and theoretical points of view—is not exceeded by that of any other family of the periodic system," says Prof. H. H. Sisler (University of Florida) in his introduction to Group VA of the periodic system. A brief introduction compares the atomic structures and physical properties of the five elements (N, P, As, Sb, Bi) in this group and lists their isotopes.

The next 100 pages are devoted to the chemistry of the nitrogen compounds, and the following 50 pages to compounds of the other four elements. Because much of this space is devoted to phosphorus, disappointingly little remains for arsenic, antimony and bismuth. The emphasis is on the descriptive inorganic chemistry and structural chemistry, whereas Yost and Russell give many more physical data in their discussion of nitrogen and phosphorus.

Industrial processes of manufacture of the elements or compounds aren't given in detail, as they are for copper, silver and gold in Vol. II. Diagrams and charts are used more fre-

quently and effectively than in some previous volumes.

Part two of this volume (about 50 pages), on nonaqueous chemistry, is by A. R. Pray (University of Minnesota). Much of this discussion naturally deals with liquid ammonia as a solvent and ionizing medium. Other solvents discussed are acetic acid, sulfur dioxide, hydrogen cyanide, phosgene and selenium oxychloride. It would seem that some tabulation of other solvents and leading references might have been given.

Coordination Chemistry

THE CHEMISTRY OF THE COORDINATION COMPOUNDS. Edited by John C. Bailar, Jr. Reinhold Publishing Corp., New York. 834 pages. $18.50.

Reviewed by A. E. Carter

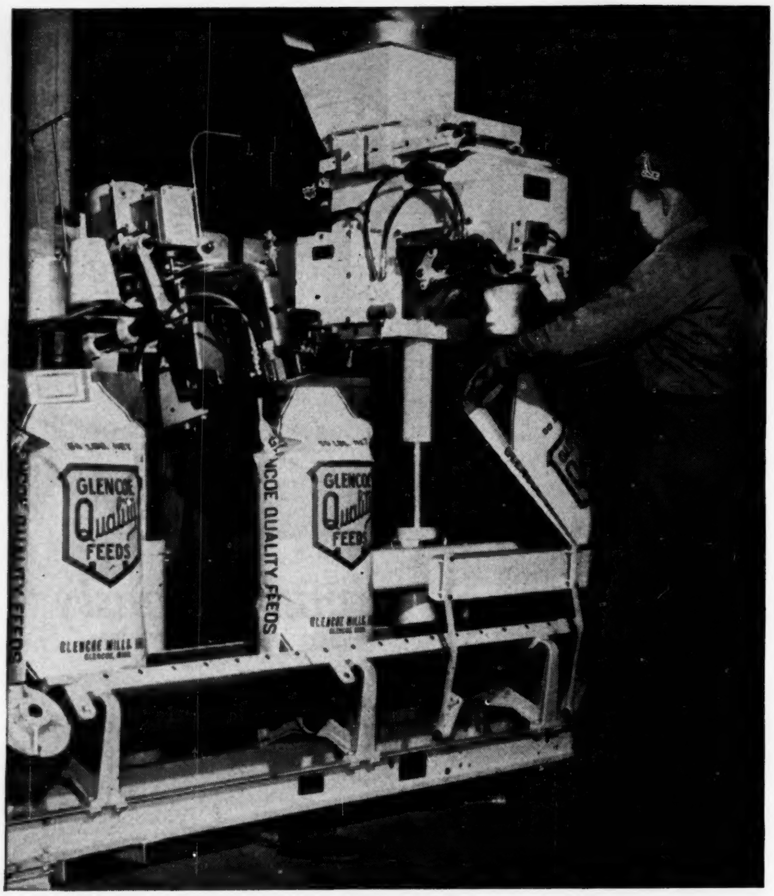
Dr. Bailar and 22 associates have, in this book, presented a comprehensive survey of coordination chemistry.

A general outline of the field is followed by discussions of coordination theories, chelation, isomerism (particularly stereoisomerism), acid-base behavior and olation. Special groups of coordination compounds—e.g., poly acids, metal carbonyls and nitrosyls, compounds of metal ions with olefins—are considered in separate chapters. Finally, a brief summary is given of physical experimental methods and of practical applications in electroposition, analytical chemistry and natural products.

This volume, with its extensive bibliography, is a major contribution to this important field of chemistry.

Briefly Noted

NATIONAL FIRE CODES, 1956. 4,400 pp. $6 *per vol. Publications Dept., National Fire Protection Assn., 60 Batterymarch St., Boston, Mass.* Compilation of 174 fire safety standards in a revised, six-volume edition. Volumes include: "Flammable Liquids and Gases," Vol. I; "Combustible Solids, Dusts, Chemicals and Explosives," Vol. II; "Building Construction and Equipment," Vol. III; "Extinguishing Equipment," Vol. IV; "Electrical," Vol. V;



"Transportation and Miscellany," Vol. VI.

TITANIUM, ZIRCONIUM AND SOME OTHER ELEMENTS OF GROWING INDUSTRIAL IMPORTANCE. 123 *pp.* $1.50. *Organisation for European Economic Co-operation, 2000 P St., N. W., Washington 6, D. C.* Devoted mainly to titanium (production of sponge, melting, fabrication, analysis, use of metal and its alloys, economics); zirconium (production of sponge, melting, fabrication); beryllium (production). Also includes discussion of tantalum and other refractory metals (molybdenum, tungsten); semiconductor metals, their production and purification.

THERMODYNAMIC TABLES AND OTHER DATA. 23 *pp.* 50¢. *Edited by R. W. Haywood. Cambridge University Press, 32 E. 57th St., New York 22, N. Y.* Features five steam tables (including enthalpy, entropy and density of superheated steam) and four refrigerant tables (for ammonia, carbon dioxide, Freon-12, methyl chloride).

METHODS FOR REDUCING THE EFFECT OF BAROMETRIC PRESSURE IN MEASUREMENT OF OCTANE NUMBER. 28 *pp.* $1.50. *By Bruno R. Siegel. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.* Presents results of altitude chamber tests on fuels in which inlet temperature and compression ratio were adjusted in combination to produce more uniform temperature-density relationship regardless of barometric pressure. Results are in form of tables of empirically determined operating conditions that will lead to substantially the same octane number when operated at any atmospheric pressure between 21.0 and 0.5 in. of mercury absolute.

APPRAISAL AND VALUATION MANUAL. 55 *pp.* $15. *Manual Div., American Society of Appraisers, 119 W. 57th St., New York 19, N. Y.* Source book of latest authoritative information on the solution to appraisal and valuation problems encountered in business and government.

CLASSIFIED LIST OF EQUIPMENT AND SERVICES. 80 *pp.* 5 *s. Council of British Manufacturers of Petroleum Equipment, 2 Princes Row, Buckingham Palace Rd., London, S.W. 1, England.* Brings up to date the 1955-56 section of the "Catalogue of British Petroleum Equipment."

THE PHYSICS OF NUCLEAR REACTORS. 112 *pp.* 25 *s. Institute of Physics,* 47 *Belgrave Sq., London, S.W.* 1, *England.* Proceedings of a London conference arranged by the Institute of Physics in collaboration with British Nuclear Energy Conference (July 3-6, 1956). Among subjects discussed are: scientific problems in development of nuclear power; shielding for reactors; control, instrumentation of reactors.

ACCEPTANCE TEST PROCEDURE FOR INDUSTRIAL WATER-COOLING TOWERS. *Bulletin ATP*-105. 4 *pp.* $1. *Cooling Tower Institute,* 446 *Emerson St., Palo Alto, Calif.* Describes methods and instrumentation for conditions and measurements in determining water-cooling capacity of mechanical-draft industrial towers. Includes photographs of ATP-106 forms used by CTI observer.

REDWOOD LUMBER SPECIFICATIONS FOR APPLICATION IN INDUSTRIAL WATER-COOLING TOWERS. Bulletin *STD*-103. 5 *pp.* $1. *Cooling Tower Institute,* 446 *Emerson St., Palo Alto, Calif.* Supersedes earlier bulletins STD-101 and STD-102. Combines complete description of CTI grades of redwood lumber for use in construction of industrial water-cooling towers and corresponding allowable design stress values for applications of CTI grades in framework design.

More New Books

ATMOSPHERIC POLLUTION. By A. R. Meetham. Pergamon Press. 63 s.

BIOLOGICAL TREATMENT OF SEWAGE AND INDUSTRIAL WASTES. Vol. I. Aerobic Oxidation. Reinhold. $10.

CHEMICAL PROCESS ECONOMICS IN PRACTICE. Edited by J. J. Hur. Reinhold. $3.95.

CHEMISTRY OF PETROCHEMICALS. By M. J. Astle. Reinhold. $6.50.

CHROMIUM. Vol. 2. Metallurgy of Chromium and its Alloys. Edited by M. J. Udy. Reinhold. $11.

MODERN INSTRUMENTS IN CHEMICAL ANALYSIS. By F. M. Biffen and W. Seaman. McGraw-Hill. $7.50.

ORGANO-METALLIC COMPOUNDS. By G. E. Coates. Wiley. $2.50.

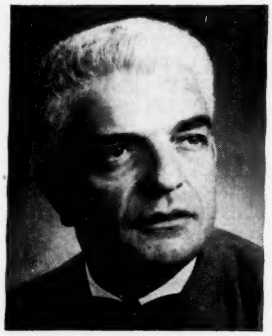
REAMUR'S MEMOIRS ON STEEL AND IRON. By A. G. Sisco. University of Chicago Press. $6.

RHEOLOGY. Vol. I. Theory and Applications. Edited by F. R. Eirich. Academic Press. $20.

VISCOUS FLOW THEORY. Vol. I. Laminar Flow. By Shih-I Pai. Van Nostrand. $7.75.

PEOPLE . . .

MEET YOUR



Max Leva

FLOW THROUGH PACKINGS AND BEDS—INTRODUCTION. PAGE 204.

Consulting Chemical Engineer Max Leva has written an extremely comprehensive series of articles which starts with this issue and will take about a year to complete.

His background in liquid-gas contacting and in fluidization is extensive and, for that matter, internationally recognized. In Pittsburgh, he operates an engineering research laboratory and a consulting practice as well. Development of industrial equipment and processes is his specialty.

Leva's undergraduate work at the University of Cincinnati earned him a bachelor's degree in chemical engineering in 1941. Four years later, he took on a master's in the same branch of engineering at Carnegie Institute of Technology. He holds a professional engineering license in Pennsylvania and has authored a number of technical articles. Some years ago, he also turned out a book, "Tower Packings and Packed Tower Design," (published by U. S. Stoneware Co.) which is now in its seceond edition.

Max Leva's professional life has included periods as a design engineer with such concerns as Blaw-Knox and Vulcan Copper & Supply. More recently, he served the U. S. Bureau of Mines, engaged in research on the technology and engineering problems of the Fischer-Tropsch process and coal gasification.

AUTHORS...

EDITED BY M. A. GIBBONS

When he left the Bureau of Mines seven years ago, he went into consulting work for chemical and chemical equipment firms—primarily in the fields of gas absorption, distillation, extraction, fluidization applications, gas making and gas purification.

Leva is married and has two daughters and a son. Though his periods of relaxation often resemble the traditional busman's holiday—work on new ideas in his laboratory—he does find time, once in a while, for his other hobbies. He likes classical music, gets a kick out of making home movies with his Bolex camera, and loves to travel.

A. C. Reents

COSTS FOR DEIONIZING WATER. PAGE 206.

The year 1946 marks Curt Reents' entry into the ion exchange field. That was the year he took a temporary job with the Illinois Water Treatment Co. between the date of his discharge from the Navy and the beginning of the 1946-47 school year. This work sparked his interest in the real potential of ion exchange materials and processes.

Soon he signed up for the master's curriculum in chemical engineering at Iowa State College. There he studied under Dr. O. R. Sweeney—a pioneer in ion exchange techniques in the United States. Following graduation, in August 1947, he returned to the Illinois Water Treatment Co. Then two years later, he became the firm's director of research.

AUTHORS . . .

Major contributions to the industry stack up this way: He's responsible for the conception and development of the mixed-bed method of ion exchange and of new processes for the purification of aqueous solutions of organic chemicals, such as glycerine and sugar.

Reents' education before his specialization in ion exchange gives him a well diversified background. He graduated from Bradley University at Peoria, Ill., in 1943, with a B. S. degree in chemistry. Later, he took on a concentrated three-month course in general engineering at the U. S. Naval Academy at Annapolis, Md. This period of study was followed by specialization in marine diesel engineering at Penn State.

He is a member of the American Institute of Chemical Engineers, the American Chemical Society and Sigma Chi.

Leland C. Campbell

BANISH YOUR STEAM TRAP TROUBLES. PAGE 227.

Campbell is southwestern representative in charge of Yarnall-Waring's Dallas office and is a member of the Engineering Club of Dallas.

In his early years, Campbell lived in Oklahoma City. Following graduation from Purdue University as a mechanical engineer, during the depths of the depression, Campbell was a metallurgist for Noblick-Sparks of Indianapolis. From 1934 to 1941, he was an experimental and development engineer on air conditioning equipment and, later, general manager for Snoair Air Co. of Bartlesville, Okla., and Dallas, Tex.

During World War II, Campbell served as ordnance officer for the first Task Force to the Aleutian Islands. Later, he became technical inspector and advisor of maintenance and supply of the ordnance activities for the Alaskan Department. He spent a total of thirty-three months in that theater.

Back in the States, Campbell served nine months with the 8th Service Command Headquarters at Dallas, Tex., before being separated in the spring of 1946 as a major.

Before joining Yarnall-Waring in 1948, Campbell was in general contracting and maintenance work for a year and a half.

Victor Pratt

"BLADDER VALVE" SEALS CIRCULAR DUCTS. PAGE 254.

Most of Victor Pratt's professional life has been tied in intimately with the armed services.

After graduating in chemistry from Brooklyn Technical High School, in 1946, he entered Pratt Institute under the Navy V-5 program. There he received his bachelor's in chemical engineering in 1950. Following graduation, and until he was drafted in 1951, he worked for Benjamin Moore Paint Co., in New Jersey.

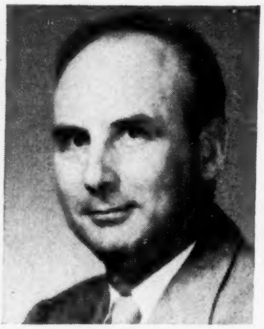
When he completed his basic training at Fort Dix, N. J., Pratt was assigned to Fort Detrick in Frederick, Md., under the Army's scientific and professional personnel utilization program.

Soon after, he was discharged from the Army but stayed on at Fort Detrick as a chemical engineer in the engineering research division. Currently, he's employed there as a section leader in the development of specialized

AUTHORS . . .

facilities and equipment for the Chemical Corps.

Pratt is 28 years old, married, and the father of two boys (aged 3 and 1½). His interest in gardening gets full play since he lives on a 17-acre "farmette" which he remodeled and landscaped himself. Other major hobbies include photography and the raising of tropical fish.



Maxey Brooke

CE FLOW FILE. PAGE 264.

Maxey Brooke is with Phillips Petroleum Co., in Texas. His work is principally administrative although he's classified as a supervisory chemist.

After graduating from the University of Oklahoma with a degree in chemical engineering in 1935, he spent the depression years in a motley collection of jobs—truck driver, pipeliner, seismographic crew member and in construction work. In 1940, Brooke joined a sulfur company on the Gulf Coast as a chemist.

His first assignment in the chemical field was followed by a term with the U. S. Army Chemical Corps: a two-year stint, part of which he spent as an observer at the Bikini atom bomb tests. It was at this time—during spare moments at Bikini—that he initiated the collection of fluid flow formulas which resulted in the present series.

At the end of his military assignment, Brooke accepted a position as water and corrosion engineer with Phillips Petroleum Co. and has continued with them for the past ten years.

He is married and has two children. An interesting sidelight is his hobby: He writes technical books and detective stories.

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PEOPLE . . .

LETTERS:

What About Reciprocity?

Sir:

The latest annual report of the Arizona State Board of Technical Registration for Architects, Engineers, Land Surveyors and Assayers contains the statement, ". . . National Council of State Boards of Technical Registration. Reciprocal registration cards are no longer supplied by this Council, and they are not recognized by member boards."

This seems to be opposite to the advice you have been giving in your articles on registration (see *Chem. Eng.*, Oct. 1956, pp. 226-232). What is correct?

HAROLD NEVIN CAREY
Registered Civil Engineer
Phoenix, Ariz.

Sir:

What was intended in the statement quoted above, I am sure, for "National Council of State Boards of Technical Registration" is National Council of State Boards of Engineering Examiners (NCSBEE), located at Columbia, S. C. As I understand it, "reciprocal registration cards" have never been supplied by NCSBEE.

Reciprocal registration is not the same as "registration by endorsement." Agreements of reciprocity, written or verbal, between states may be terminated by either party at will without notice. Only two states have reported registration of out-of-state candidates on the basis of reciprocal agreements.

As pointed out in my article, dissimilar standards place one of the boards in the position of granting to out-of-state candidates privileges it cannot grant to its own citizens. However, all boards realize that there should be some uniformity in requirements, such uniformity being nurtured through NCSBEE and its several working committees.

Licensure by endorsement, as extended by most states, requires the applicant to have already been licensed in his home state. Thus, if you passed a written examination for licens-

PRO & CON

EDITED BY C. H. CHILTON

ure in Arizona and applied for licensure in New York on that basis, you would obtain it by endorsement (without written examination) if the examination taken in Arizona was deemed comparable to that for New York at the time the examination was taken.

JOHN D. CONSTANCE
Professional Engineer
Cliffside Park, N. J.

Simplicity vs. Reliability

Sir:

Your October issue (pp. 204-210) carries W. Hartwick's article on "Improve Your Compressor Design With New Calculation Method."

A study of Mr. Hartwick's Table II shows that his proposed method is satisfactory as the gases approach ideal behavior. Even when gases are initially at such a temperature and pressure as to be near the critical state, sometimes their properties are such that isentropic compression will remove them further from the critical state. The new method will give satisfactory answers for such gases, but will not always indicate with reliability the proximity of the final state to the critical state.

On the other hand, for gases such as normal butane, isentropic compression from saturation can lead close to the critical state and cause untoward changes in enthalpy. For such gases, any simplified or short-cut method will be risky for compressor design. A similar line of reasoning applies to gases under extremely high pressures where their behavior approaches liquids in compressibility.

If the designer of reciprocating compressors wants the best answer, he must resort to the more tedious, perhaps, but also the more accurate and reliable method of estimating isentropic changes in enthalphy (p. 210, Ref. 12).

When compressor performance shows significant deviations based on actual enthalpy changes, then the designers and manu-

facturers should pay more attention to the mechanical features of reciprocating compressors, such as the design and arrangements of cylinders, valves and cooling surfaces.

ROBERT YORK

Cornell University
Ithaca, N. Y.

NEIL H. McELROY
Procter & Gamble
$320,317

<$285,000

Pro: Executive Salaries

Sir:

I commend your effective endeavor to offset some of the negative points that have been made about salaries ("Why Are They Worth So Much?", *Chem. Eng.*, Nov. 1956, pp. 238-244).

The only question I have is whether it is proper to add a profit-sharing-trust credit to salary and bonus income to produce a total for any given year. The profit-sharing credit is available only at the time of retirement and is not a factor in annual income.

NEIL MCELROY

Procter & Gamble Co.
Cincinnati, Ohio

Pro: Vapor Compression

Sir:

Your article on sea-water evaporation in the October issue (pp. 126-134) discusses a subject of intense interest to many areas of the world. It was not only very timely, but its impact on areas of water shortage should be great.

On p. 126 you state: "Engineers today are hard at work on alternative processes, such as...

vapor compression. . . . None of these has yet had a full-dress tryout."

This is a serious misstatement. The fact is that we have successfully placed into service 4,398 vapor-compression water evaporators in the last 12 years in 22 different countries. The vapor-compression evaporator is not new and untried; it is a well-established, field-tested and proved method of producing pure water, noted for its high energy efficiency. (Of course, in areas such as Kuwait, where natural gas is considered waste, energy efficiency is of no consequence.)

Vapor compression is the best solution in many applications. As a firm that designs, fabricates and installs either submerged-tube, flash-type or vapor-compression evaporators, we feel that our position and observations are unbiased.

K. K. HILGENDORF
Cleaver-Brooks Co.
Milwaukee, Wis.

▶ *Our statement that vapor-compression evaporation has not yet had a "full-dress tryout" was admittedly too broad. What we should have said was that vapor compression has not yet been used in installations as big as those being built for Kuwait and Aruba. Cleaver-Brooks' largest unit is apparently rated at 50,000 gal./day, whereas the evaporation units described in our article are rated at ten or more times that figure.*—ED.

Pro: Statistics Refresher

Sir:

One of the most important assets to all engineering has been completely missed by your staff, and that is the brand-new science called "applied statistics," or more widely referred to as "statistical quality control."

In the last 15 years you have published about a half-dozen very good articles. However, the basic concepts for the engineer in the field have been overlooked. You would have to be a very good quality-control engineer to use the articles published so far. The beginner would be led into a bottomless pit from which he would find no escape.

You need to publish a complete course, like your *CE* Refresher, having the following materials:

Basic math for basic statistics, followed by basic statistics and leading into statistical quality control. This would cover experiments, applications and theory.

The topics covered would be: Distribution curves, simple probability, X-bar and R-charts for process control, p and c-charts for defectives and defects, acceptance sampling, tests of significance, analysis of variance, ranking, correlation and regression, experimental designs, linear programming and, finally, the Boxonian technique and the very-high-level operations research.

These topics should be presented at three levels: First, or beginner's; second, an intermediate course; and third, a mature course in which the decisions are much more difficult to make and the analysis of data is more difficult. One may need more maturity in math.

If you consider my suggestions you should be able to double your circulation in less than five years.

E. D. Robinson

Plough, Inc.
Memphis, Tenn.

► *We agree with Mr. Robinson that the application of statistical methods to problems in chemical engineering is important. That's why we published a 26-page report on Industrial Statistics in our March 1956 issue (pp. 165-190). This report covered distribution curves, probability, tests of significance, analysis of variance, ranking, correlation and regression, curve fitting and a short discussion on quality control.*

Our August issue carried two articles on linear programming (pp. 211-216), and we have on our tentative schedule for this year a comprehensive article on the Boxonian technique.

Mr. Robinson's accusation about the beginner in the bottomless pit can be answered by a statement of editorial policy. Any technical publication must decide whether to aim at the neophyte or the specialist, or somewhere in between. We edit our material at the level which we believe is most useful to the technically trained professional man in the chemical process industries. That's why we omit or minimize treatment of any subject at the beginner's level.

On the other hand, we try to avoid editing at a level which will

be understood and appreciated only by specialists in the particular field covered by the article. How well we succeed in that endeavor can be inferred from the following comment from a professor of biological statistics.—ED.

Con: Low-Brow Statistics

Sir:

I recently had cause to read William Volk's Industrial Statistics report (Mar. 1956, pp. 165-190). Though I dislike saying so, I feel that I must say that, while the idea of such a paper is good, there are enough misconceptions presented there to do statistics a disservice. . . .

It seems to me that, for the sake of statistics and *Chemical Engineering*, this entire report should be reviewed and corrected in the shortest possible time.

ROBERT G. D. STEEL
Dept. of Plant Breeding
Cornell University
Ithaca, N. Y.

▶ *Prof. Steel's letter contained several specific criticisms which we brought to Author Volk's attention, resulting in the reply which follows.*—ED.

Pro: Low-Brow Statistics

Sir:

I'm sorry that Prof. Steel feels that my article has done statistics a disservice. Such would be exactly contrary to the purpose of the article, which was to present a readable account of some statistical techniques to chemical engineers.

I can understand his discomfort. This feeling always occurs when one reads a popularization of a subject in which he specializes. The fine points which add sparkle and zest to the subject have been rounded off and dulled to meet a lower common denominator.

I do not believe there are any misconceptions in the article. I was aware of the liberties I took in order to simplify the presentation. True, many important points have been glossed over or omitted, but I feel from the response I have received that the article has stirred up an interest in statistics in a fairly large group. (There were some typographical errors which were

corrected via a letter you published in your November issue.)

I believe the article should be judged from the point of view of the engineer who, if he finds the subject interesting, will go on to broaden his knowledge in more exact presentations, rather than from that of the statistician, to whom the exact presentation is fundamental.

WILLIAM VOLK
Hydrocarbon Research, Inc.
Trenton, N. J.

He Gets His Two-Cents Worth

Sir:

You are undoubtedly interested in learning how your readers value your publication. I can give you a specific dollars-and-cents figure as it pertains to your annual Inventory issue.

The 1956 Inventory issue weighed just under 2 lb. At the approximate market price of \$18/ton that a paperboard mill pays for this grade of waste paper, this figures out to just about 2¢.

Putting a monetary value on your other 12 issues a year is more difficult, inasmuch as there are almost always articles worth reading and saving.

R. H. BERNSTEIN
New Haven Board & Carton Co.
New Haven, Conn.

▶ *The value Mr. Bernstein places on our Inventory issue is the record low. At the other end of the scale is the executive from St. Louis who told us that our Inventory issue was "worth thousands of dollars each year" to his company. Seems that his company had decided that such a continuing inventory was necesaary if it wanted to be in a position to spot long-range trends in processes, products and equipment. Our Inventory issue saved them the expense and trouble of doing a similar job each year.*—ED.

Con Ford, Pro Stewart

Sir:

What execrable logic Robert J. Ford displays (Pro & Con, Nov. 1956, p. 402) in his reply to the question, "Does Chemical Engineering Pay?"! He reasons that because, as a 1951 graduate, he receives more compensation than a 1956 graduate, ergo: Chemical engineering is a sound profession.

Rather than criticize the editors of *Chemical Engineering* for publishing the truth—no matter how unpopular it is—I suggest that Mr. Ford spend some time contemplating the strange phenomenon that *Chemical Engineering* has on several occasions in the last few years published the unpleasant truth about the alleged shortage of engineers, despite the fact that its principal source of income (i.e., advertising revenue) is from the group who are lamenting about the engineer shortage.

At present there is no shortage, because the demand for engineers is still weak, and the law of supply and demand is not in full effect. This may come as an astounding statement to the captains of industry and the 1951 graduates, who still have to experience their first layoff, but I can prove it.

For example, I applied to Chemstrand Corp., Mr. Ford's present employer, for employment in 1953 while I was working on the design of the Chemstrand plant for a job shop. I was refused employment because of my advanced age of 48!

If you publish this letter, please withhold my name for, after all, the layoffs may come even next month, and I'll be job-hunting again under normal conditions.

PAST SUPERANNUATED
Registered Professional Engineer
Azusa, Calif.

We welcome short, pertinent letters from our readers giving their opinions on developments in the chemical engineering profession and in the chemical process industries. Address the Editor, Chemical Engineering, 330 West 42nd Street, New York 36, N. Y.

PEOPLE . . .

NAMES IN

George C. Ellis

Stauffer Chemical Co. has announced the appointment of George Ellis as a senior vice-president of the firm and general manager of the West End Chemical division. He has also been elected to Stauffer's board of directors.

Ellis is one of the pioneers in the field of boron chemicals. He was among the original organizers of West End Chemical and has been an officer and director of that company for the past 26 years. He has served as West End's president since 1943.

David L. Grimes has been appointed president of Narmco, Inc., San Diego, Calif., research and development concern. He succeeds the firm's founder **Glenn C. Havens** who is now chairman.

Thomas B. Davis has been appointed production superintendent of NRC Metals' Santa Rosa, Fla., plant. Formerly, he was associated with du Pont as production supervisor at Newport, Del.

J. Graham McQuarrie has been promoted from senior process statistician to assistant superintendent in the production coordination department of Monsanto Chemical Co., Texas City, Tex.

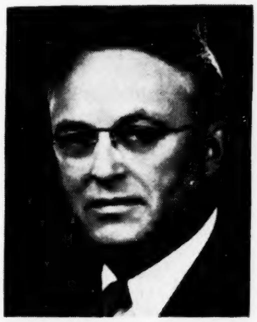
Hans K. W. Eckoldt has been appointed associate patent counsel for Mobay Chemical Co., St. Louis. He held a similar position in recent years

THE NEWS

EDITED BY M. A. GIBBONS

with Farbenfabriken-Bayer, A. G., Germany.

William Leaders, former manager of the development department of Mallinckrodt Chemical Works' uranium division, is now technical director of the firm's new special metals division. **G. W. Tompkin** is the division's production manager.



Bruce K. Brown

New president and chief executive officer of Petroleum Chemicals, Inc., is Bruce K. Brown of New Orleans.

Brown was former deputy administrator of the Petroleum Administration for Defense and, until recently, president of Pan-Am Southern Corp.

From 1941 until 1944, Brown served as assistant deputy administrator for the Petroleum Administration for War. Then, in 1945, he became vice president of Standard Oil Co. (Ind.).

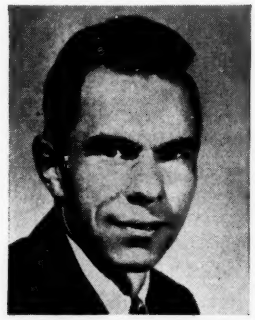
David H. Wheeler has joined Kaiser Engineers, division of Henry J. Kaiser Co., as an air pollution control engineer. Formerly, he was chief engineer for Western Precipitation Corp.

Orval Riggs has been named general manager in charge of all commercial activities for Thermco Laboratories, Michigan City, Ind.

Roland J. Maddox has joined the technical staff of Texas City Refining, Inc., at Texas

City, Tex. For the past 10 years, he has been associated with Shell Oil Co. as a staffer in the manufacturing technological department.

Winthrop M. Barnes has joined Southwest Research Institute's industrial economics staff as a process engineer. He had been with R. M. Hollingshead Corp.



Glenn Seaborg

Nobel laureate and director of chemical research for the University of California's radiation laboratory, has been chosen to receive the 1957 Perkin Medal of the American Section, Society of Chemical Industry.

Co-winner (with Edwin M. Millan) of the Nobel Prize for Chemistry in 1951, Dr. Glenn Seaborg now adds to his many honors recognition for the industrial chemical implications of his work in nuclear chemistry. He has participated in the discovery of nine trans-uranium chemical elements as well as radioactive isotopes of these elements.

Seaborg was born in Ishpeming, Michigan and is a graduate of the University of California. His home is in Berkeley.

A. C. Embshoff has retired from active management of Infilco's industrial division. He'll be succeeded by **O. E. Baker.** Embshoff will remain available to the firm as a general consultant, in Los Angeles.

C. A. Romano, resident manager of Westvaco Chlor-Alkali's plant in Green River, Wyo., since 1948, has been transferred to the corporate staff

headquarters at San Jose, Calif. He will be succeeded by **N. E. McDougal,** assistant resident manager.

Fred G. Stroke has been appointed to represent Uniform Tubes, Inc., in New England and in the province of Quebec. To date, Stroke has served as a metallurgist with the AEC and as chief metallurgist with several industrial concerns.

Howard W. Wright, Jr., has been appointed a vice-president and general manager of the separator division of Southwestern Engineering Co., Los Angeles.

Edward T. Bryand has joined the staff of Portland Copper and Tank Works, Inc., and will serve in the capacity of supervisor of the new products department.

B. A. DiLiddo has joined the staff of the B. F. Goodrich research center, Brecksville, Ohio, as a technical man. Before joining Goodrich, he was an assistant chemist for the Armour Research Foundation.

T. M. Newsom has been promoted to senior chemical engineer in the technical service division of Humble Oil & Refining's Baytown, Tex., refinery. **C. L. Thorpe** is now senior research chemist in research and development.

E. Paul Duncan has been appointed supervisor, technical service, for Hooker Electrochemical Co., Tacoma, Wash. Until now, he has been technical service representative.

John R. Davis has joined the polymer chemicals division of W. R. Grace & Co. at the Baton Rouge, La., polyolefin resin plant. For the past 8 years, he has been with Shell Chemical.

Nelson V. Seeger, pioneer in the field of urethane plastics, has been named to the newly-created post of associate director of exploratory re-

search for Diamond Alkali Co., Cleveland.

H. N. Mallon has been named to the newly-created position of chairman of the board of Dresser Industries, Inc., and will remain the firm's chief executive officer. **J. B. O'Connor,** formerly vice-president, succeeds Mallon as president.

James W. Elston has been named the first recipient of the new Marlin G. Geiger award for individual accomplishment of employees at Davison Chemical Co.

William C. Kay has been appointed assistant general manager of du Pont's organic chemicals department. **Ernest R. Bridgwater** will fill a similar post in the newly created elastomer chemicals department.

Robert F. Purcell, protective coatings chemist, has joined the expanded nitroparaffins research staff of Commercial Solvents Corp. He'll locate in Terre Haute, Ind.

Berry L. Dillon is now assistant resident manager at the San Leandro, Calif., plant of Crown Zellerbach's Western Waxide division. Formerly, he was resident manager in Kansas City, Mo.

John A. Yourtee has been appointed technical superintendent of American Viscose Corp.'s film division plant at Marcus Hook, Pa. He had been coordinator of research and development at Fredericksburg, Va.

Donald Garrett has been named assistant manager of the research department for American Potash & Chemical Corp., Trona, Calif., succeeding **Harold Mazza** who is now manager of research at the Los Angeles plant.

Louis P. Hammett, professor at Columbia University and executive officer of the chemistry department, has been named to receive the 1957 William H. Nichols Medal of

the American Chemical Society's New York section.

J. S. Barton has been named director of packaging research and development, Western-Waxide Specialty Packaging division, Crown Zellerbach Corp., in San Leandro, Calif.

E. G. Kominek and **A. A. Kalinske** have been promoted to vice presidential posts at Infilco, Inc. Kominek is also general sales manager; Kalinske is director of research and development.

Vance B. Erickson, chief chemist at the Baton Rouge plant of Kaiser Aluminum & Chemical Corp., has been transferred to the exploration department at the firm's laboratory facilities at Permanente, Calif.

Victor E. Logan has been promoted from chief operator in the pilot plant to night superintendent at Monsanto Chemical Co., Texas City, Tex.

Frederick M. Belmore, special assistant to the president of Mallinckrodt Chemical Works, has been named to head the firm's new special metals division.

Alvin C. Purdy, president of Bull & Roberts, Inc., has been elected president of the American Council of Independent Laboratories, Inc. He is also a director and past-president of the Association of Consulting Chemists & Chemical Engineers.

H. W. Schultze has joined Climax Molybdenum Co. as assistant manager of chemical development. He'll concentrate on expanding the use of molybdenum catalysts in the process industries.

J. O. Allred and **B. A. Martin** have returned to Humble Oil & Refining's technical service division from military service.

Harold A. Ford, former sales representative for Westvaco Chlor-Alkali division of Food

Machinery & Chemical, has joined the industrial chemicals division of Olin Mathieson Chemical as assistant manager of nitrogen products.

Frank B. Odasz has been promoted to manager of the development and control division of Husky Oil Co., Cody, Wyo. He had been assistant director of the firm's technical service. His new management position was created due to Husky's growing asphalt activities.

W. E. Arthur, a vice president of Bechtel International Corp., is now Bechtel's Gulf Coast representative with headquarters in Houston.

Warren B. Snow has joined the Aviation division of Olin Mathieson Chemical Corp. at Niagara Falls, N. Y., as a chemical engineer. Formerly, he worked as an area supervisor with du Pont, in Wilmington, Del.

Edward W. Comings, head of the School of Chemical and Metallurgical Engineering, Purdue University, has been named recipient of the William H. Walker Award for 1956 by the American Institute of Chemical Engineers, for his numerous articles on high pressure measurements, liquid-liquid extraction, drying and fluid flow.

Albert Schrage has joined the product development department of the chemical division of Celanese Corp. of America. Formerly, he was employed by Hudson Foam Plastics Corp.

Robert Franklin Mehl, dean of graduate studies at Carnegie Institute of Technology, has received the 1956 Pittsburgh Award of the American Chemical Society for his "outstanding contributions to the advancement of chemistry in the Pittsburgh area."

Mark T. Anthony has been named assistant to the vice president and general manager of Kaiser Steel Corp.,

Oakland, Calif. He succeeds **A. F. Scarr** who is now assistant general manager of Kaiser Center, Inc.

Robert C. Bertossa, formerly head of the Metallurgical Research Lab of Chicago Bridge and Iron Co., Birmingham, Ala., has joined the metallurgy department of Stanford Research Institute, Menlo Park, Calif.

Fred Torn will head up a new plant engineering section at American Potash & Chemical's Los Angeles plant. The department will concentrate on design of new plants and equipment as well as on the improvement of existing processes.

William H. Williams has been elected to the board of directors of the American Forest Products Corp., San Francisco.

Daniel H. Terry has been elevated from the position of research director of the Bon Ami Co., New York, to vice president in charge of research and development.

J. B. Dunlap has been named superintendent of the Martinez refinery, Shell Oil Co. **J. M. Brackenbury** has been named manager of Shell's head office manufacturing technological department.

Hugh C. Crall, Richard A. Denahan, Jr., William D. DeWitt, John C. Haaga, Joseph P. Kennedy and **Paul R. McVicker** have been added to Carbide and Carbon Chemical's engineering staff.

David W. Moriarty, James V. Nichols and **John Blackburn, Jr.,** have joined du Pont's production division, electrochemicals department.

Richard P. Mosher has just been appointed to the staff of the Tonawanda, N. Y., Laboratories of Linde Air Products Co.

Carroll A. Hockwalt, vice president for research, develop-

ment and engineering for Monsanto Chemical, has been named winner of the 1956 Midwest Award of the ACS' St. Louis section.

John C. Robinson has been appointed commercial fuel manager of the atomic energy division of Sylvania Electric Products, Inc.

Martin Aaron, former vice president of American Plastics Corp. and manager of technical procurement for Heyden Chemical, is now assistant to the president of Sam Tour & Co., New York.

Milo Buzzee, industrial designer and research engineer, has joined Tube Turns Plastics, Inc., Louisville, Ky.

R. A. Moenich has been named chief engineer for Tipp Manufacturing Co.'s newly set up controls division.

Edward G. Partridge has been appointed professor of chemical engineering at the University of So. California and technical director of the TLARGI Rubber Technology Foundation. He had been with B. F. Goodrich.

William Talbot has been appointed director of research for Kerr Mfg. Co. He had been vice president of the Rubberset division of Bristol-Meyers Co.

A. Griffin Ashcroft, former vice president and director of research and development for Alexander Smith & Sons, Inc., has joined the staff of Arthur D. Little, Inc.

Howard L. Miller, ceramic engineer with the technical division of Libbey-Owens-Ford Glass Co. for 10 years, has been named manager of the firm's technical control department in the Charleston, W. Va., plant.

Conrad Schuerch, Jr., has been named chairman of the department of forest chemistry at Syracuse University, New York.

Ferri Casciani, director of the research laboratory of the former Niagara Alkali Co., now merged into Hooker Electrochemical Co., has been named supervisor of technical service.

Eric G. Schwarz has rejoined the product development staff of Union Carbide & Carbon's silicones division, after two years with the Air Force.

OBITUARIES

Julio G. Bejarano, 54, manager of the Shell Chemical Corp., plant at Denver, died October 24 after a brief illness. During World War II he had charge of construction of the butadiene plant at Torrance, Calif., and later managed the Cactus (Tex.) Ordnance plant.

Frank Eichelberger, 71, engineer and consultant, died October 21 at his home at Hayden Lake, Ida. During 1951 and 1952, he and a group of associates founded the American Chrome Co.

Leslie H. Backer, professor emeritus and former head of the departments of chemistry and chemical engineering at Stevens Institute of Technology, died October 27 after a brief illness.

Robert Rex Shively, director and former vice president of B. F. Drakenfeld & Co., Inc., died at his home in Mt. Lebanon, Pa., after a long illness. He was 73 years old.

Frederick C. Hahn, 63, assistant to the research director of the polychemicals department at du Pont died November 3 at his home in Alapocas, Del. Hahn started his career with du Pont in 1923, spent a number of years with National Aniline and returned to du Pont in 1937.

James E. Crosby, 59, general manager of Crown Zellerbach's western waxide specialty packaging division, San Leandro, Calif., died October 20. He has been with the firm since 1919.

PEOPLE . . .

FIRMS

NEW REPRESENTATIVES

Pure Chemicals, Ltd. of Liverpool, England, has appointed Aceto Chemical Co., Flushing, N. Y., sales representative for several alkyl bromides, including isopropyl bromide, *n*-propyl bromide and octyl bromide.

Rust Engineering Co. of Pittsburgh, Pa., has appointed M. K. Griggs Co., Houston, Tex., as its Texas Representative.

Solar Aircraft Co., San Diego, Calif., has appointed Nissho Co. Ltd. of Tokyo sales representative for Sola-Flex bellows and expansion joints, Solar welding fluxes, and aircraft and engine components.

NEW LOCATIONS

Socony Mobil Oil Co. has moved to 150 East 42nd St., New York 17, N. Y.

International Minerals & Chemical Corp. has moved its general offices to Skokie, Ill.

Toms River-Cincinnati Chemical Corp., dyestuffs firm, is moving to Toms River, N. J.

General Electric Co.'s atomic power equipment department, which centralizes all company efforts in design, development, manufacturing and marketing of peacetime atomic equipment, has moved to San Jose, Calif.

Chlorine Institute is now located at 342 Madison Ave., New York 17, N. Y.

NEW LINES

Colmonoy Corp., Detroit, Mich., has a new metal spray unit of improved design for applying hard-facing alloys and other metals in powder form.

St. Regis Paper Co., New York, N. Y., will soon commence limited commercial produc-

IN THE NEWS

EDITED BY C. ROHRBACH

tion of its new expanded plastic container. This new container retains high compression strength under conditions of severe humidity.

New England Nuclear Corp., Boston, Mass., has developed an atomic flashlight which will provide light for many years, without the aid of batteries or external power sources.

Aerojet-General Nucleonics of San Ramon, Calif., has filed applications with the AEC for construction permits to produce three additional portable research and training reactors. This brings the total to four reactors presently under production by AGN.

NEW FACILITIES

Weston Electrical Instrument Corp., Newark, N. J., has opened the following district sales offices: Los Angeles, Calif.; Cincinnati, Ohio; Philadelphia, Pa.; Union, N. J.

American Oil Co. is building a 25,000 bbl./day processing unit for the production of asphalt at its Yorktown, Va., refinery.

Electro Metallurgical Co. has opened a new eastern sales office in Phillipsburg, N. J.

Petroquimica Cubana, S. A., is constructing the first unit of a $10-million petrochemical plant in Santiago de Cuba. The first of two expected plant units will be a $2-million plant for the production of caustic soda, chlorine and hydrogen.

National Cylinder Gas Co. is building a hydrogen producing plant in St. Paul, Minn. The new plant will manufacture hydrogen by the electrolytic method.

Republic Steel Corp. is installing equipment for the manu-

facture of plastic line and irrigation pipe up to the diameter of eight inches at its plastics products div. plant in Magnolia, Ark.

Saskatchewan Cement Corp. has a new $8-million plant near Regina, Canada. The plant has a rated capacity of 850,000 bbl./yr.

A. Hollander & Son, Inc., has acquired Brook Chemical Co. and several affiliated companies. Brook and the affiliated companies are engaged in the purchase and sale of chemicals, intermediates and dyestuffs for the textile, fur, paper and leather trades.

Kendall Co. is constructing a $1.3-million plant to produce Polyken industrial tapes, plastic film and plastic specialties in Franklin, Ky.

Socony Mobil Co. is constructing a 3,250 bbl./day catalytic reformer and a 3,000 bbl./day hydro-desulfurizer at its Casper Wyo., refinery.

Chain Belt Co., Milwaukee, Wis., has acquired General Road Machines, Inc., of Niles and Newton Falls, Ohio, to complement its road machinery line.

Trinity Equipment Corp. is manufacturing thermowells and dehumidifiers at Cortland, N. Y.

Minneapolis-Honeywell Regulator Co. is building a manufacturing plant and home office for its valve division at Fort Washington, Pa.

Olin Mathieson Chemical Corp. is building a $1.5-million plant to produce automotive anti-freeze at Mapleton, Ill.

Carbide & Carbon Chemicals Co. is constructing a multi-million dollar development laboratory in South Charleston, W. Va. Completion is scheduled for mid-1958.

Henry Bower Chemical Mfg. Co. is producing cuprous chloride at its plant in Phildelphia, Pa.

Quaker Oats Co. has opened a new scientific research center in Barrington, Ill.

H. B. Fuller Co., manufacturer of industrial adhesives, has a new plant and offices in South San Francisco, Calif.

Titanium Metals Corp. of America has purchased from Louis Berkman Co. its Ohio River Steel Div. plant, Toronto, Ohio, and reportedly plans to convert this mill into the first specialized and exclusive facility for rolling and forging titanium.

J. & J. Rogers Co. is building a $10-million newsprint mill in Silt, Colo.

Olin Revere Shipping Corp., Monrovia, Liberia, is building three specially-designed bauxite carriers. Each one will haul 14,000 tons of cargo at a draft of 21.5 ft.

Continental Oil Co. will spend more than $4 million on its research and development program this year. Included in this program is a $500,000 atomic radiation laboratory at Ponca City, Okla.

Standard Oil Co. of Indiana is constructing a new Ultraforming unit in Neodesha, Kan., to process more than 6,000 bbl./day of naphtha.

Halstad Elevator Co., Halstad, Minn., is building a $200,000 soybean processing plant.

American Pulley Co., Philadelphia, Pa., has purchased the materials-handling division of Market Forge Co.

Great Northern Oil Co. has a new 5.2-million cu. ft./day catalytic desulfurization unit at its Pine Bend, Minn., refinery.

Mellon Institute is constructing a $1-million laboratory to house its recently established department of radiation research.

Texas Co.'s refinery at Port Arthur, Tex., is constructing

FIRMS . . .

one of the world's largest fluid catalytic cracking units. The new unit will have a rated throughput capacity of 90,000 bbl./day, including 30,000 bbl. of recycle stock.

Dayton Rubber Co., Dayton, Ohio, has established a new division to provide two-component liquid systems, custom formulated to industry requirements, for the forming of urethane foam materials.

Container Corp. of America is building a corrugated container plant in Dolton, Ill. The plant is expected to be in operation by mid-1957.

General Electric Co., Schenectady, N. Y., has opened its $1,-million bearing and lubricant center, the largest test and development facility of its kind in American industry.

Schutte Pulverizer Co. has moved into a newly purchased building at 878 Bailey Ave., Buffalo 6, N. Y. with more than 50% increased manufacturing and office area.

Chas. Pfizer & Co. has opened a new manufacturing plant at Arnprior, Ont. This company has also opened its new midwestern distribution center in Chicago, Ill.

United States Rubber Co. has acquired North British Rubber Co., Ltd., of Edinburgh.

Columbian Carbon Co. has opened its third plant for manufacturing collodial dispersions of carbon black in Tacony (Philadelphia), Pa.

General Aniline & Film Corp. is erecting a machine production plant by its Ozalid Div. at Vestal, N. Y.

Chemical Construction Corp. is expanding its engineering design and construction services and will undertake projects in both the chemical and petrochemical processing industries.

General Petroleum Co. is increasing capacity of its Fern-

dale, Wash., refinery from 35,000 bbl./day to 48,000 bbl./day.

International Minerals & Chemical Corp. is building new general headquarters offices in Skokie, Ill.

Celanese Corp. of America has acquired a $1-million oxygen generator for its Bishop, Tex., plant.

J. T. Baker Chemical Co., Phillipsburg, N. J., has a new research laboratory building.

American Potash & Chemical Corp. has established a plant engineering section at the Los Angeles plant to provide technical services.

Crucible Steel Co. of America has acquired Vacuum Metals Corp. at Syracuse, N. Y.

Reynolds Metals Co. has acquired a 4,000-acre tract adjacent to Lake Desmet, Wyo., to construct an aluminum reduction plant.

Atomic Fuel Extraction Corp., Pocatello, Idaho, has acquired Wolf Oil & Gas Co.

Crown Zellerbach Corp. is constructing a converting plant at Antioch, Calif., to cost $8 million. It will make tissue, towels, napkins and bags.

J. B. Beaird Co. has installed a $160,000 stress relieving furnace at its Shreveport, La., plant.

Farbwerke Hoechst AG. has expanded its operations and built a new plant in the vicinity of Kassel, West Germany, for the production of crude montan wax.

Soil Builders International Corp. has acquired Aluminum & Chemical Corp. in Newport, Ark., manufacturers of aluminum rolling mill products.

West Virginia Pulp & Paper Co. has authorized a $50-million expansion program at Luke, Md. The installation of two large paper machines will ul-

timately increase West Virginia's pulp production at Luke to more than 800 tons/day, or about double present capacity.

Canadian Industries Ltd. has purchased William Stone Sons Ltd., of Ingersoll, Ont., producers of fertilizers and feed and hides.

National Cylinder Gas Co. is expanding its hydrogen producing facilities at Kenosha, Wis. to increase capacity by approximately 30%.

Battelle Memorial Institute, Columbus, Ohio, has completed the nation's first privately owned nuclear research center.

Dewey & Almy Chemical Co., Cambridge, Mass., is constructing a new $500,000 pilot laboratory.

McGregor-Michigan Corp., steel plate fabricators, has a new heavy fabricating plant in Detroit, Mich.

Metro-Atlantic, Inc., is constructing a new dyestuff application and service laboratory in Centredale, R. I.

Creole Petroleum Corp. is installing a lube hydrofiner at the Amuay Bay, Venezuela refinery.

Kaiser Gypsum Co., Oakland, Calif., has purchased Fir-Tex Insulating Board, Inc.

Mathews Paint Co. is planning a $300,000 Arizona expansion program including a manufacturing plant.

National Starch Products Inc. has acquired Granite Board, Inc., Goffstown, N. H., leading manufacturer of wood particle board.

Stein, Hall & Co. has a new plant, office, laboratory and warehouse building in Charlotte, N. C.

Arthur D. Little Inc. is establishing a laboratory for fundamental research supported

by funds from American industries at Inveresk near Edinburgh, Scotland.

Texas Portland Cement Co. has started production at its plant in Echo near Orange, Tex.

Lion Oil Co. is constructing a nitric acid concentrator at the El Dorado, Ark., chemical plant. It is expected to produce, under normal operation, 40 tons/day of nitric acid of 95% strength.

Catalin Corp. of America is constructing a $500,000 laboratory for the development of special chemicals at the Fords, N. J. plant.

Hydrometals, Inc. is erecting a strip mill at 2959 West 47th St., Chicago, Ill.

Pure Oil Co. will expand its Lemont, Ill., refinery by adding a fixed bed catalytic reformer and auxiliary equipment.

Air Reduction Co. is building a second Chicago plant at 120th St. and Doty Ave. Gases will be marketed to Calumet area customers.

Aceme Printing Ink Co. has purchased a building at 5005 South Mason Ave., Chicago, Ill., to expand its rotogravure and flexographic divisions.

Bell Co., manufacturer of hydraulic brake fluid, transmission fluid and other automotive chemicals, has bought a building at 1840 West Kinzie St., Chicago, Ill., to expand its operations.

National Gypsum Co., Buffalo, N. Y., is planning a $19-million expansion program involving construction of two gypsum building products plants and the development of a 75-million-ton northern Michigan gypsum deposit.

Vitro Corp. of America's uranium division has signed a multi-million dollar contract with the U. S. Atomic Energy Commission for production of uranium concentrates. Vitro

will spend $1.2 million to expand its production facilities in Salt Lake City and install a new process of recovering uranium concentrates from ore.

Consolidated Mining & Smelting Co. has bought from the U. S. government the heavy water plant located at the company's chemical fertilizer operation at Trail, B. C.

G. Barr & Co. has installed five propellant storage tanks, with a combined capacity of 380,000 lb., at its Chicago plant.

George L. Nankervis Co. has completed a multi-million dollar facility to accommodate its manufacturing operations.

Stauffer Chemical Co. has established another unit in its 17-plant network of agricultural chemical plants at Phoenix, Ariz.

Kaiser Aluminum & Chemical Corp., Oakland, Calif., is acquiring Hokin Aluminum Co. extrusion plant at Dolton, Ill.

Laboratories Lederle Mexico, S. A., an American Cyanamid Co. subsidiary, has gone into the production of the broad spectrum antibiotics, Achromycin tetracycline, Aureomycin chlortetracycline and other drugs.

G. D. Searle & Co., Chicago, Ill., is expanding its facilities in Great Britain to provide for increased production of pharmaceuticals to serve overseas markets.

National Industrial Development Corp., owned entirely by the Indian government, is undertaking the manufacture of primary intermediates required for the production of dyestuffs.

Nisso Steel Mfg. Co., Tokyo, Japan, is developing a 300 ton/mo. titanium dioxide plant.

Reichhold Chemicals, Inc., White Plains, N. Y., is building two new formaldehyde

plants and will increase output of two other basic chemicals, pentaerythritol and phenol.

British Titan Products Co. Ltd. is expanding its production facilities at Grimsby, England, at a cost of more than $5.6 million.

General Petroleum Corp. is expanding its Ferndale, Wash., refinery to 48,000-bbl./day capacity.

Chemische Werke Huels AG in Marl, West Germany, has a new pilot plant for the production of about 50 tons/mo. of low pressure polyethylene.

Waldorf Paper Products Co. is building a $6-million pulp mill with a capacity of 250 tons/day near Missoula, Mont.

Electronic Associates, Inc., has opened the E. A. I. Computation Center in El Segundo, Calif., said to be the largest analog computer facility available for industry on the West Coast.

NEW COMPANIES

General Adhesives Co., 6100 Centennial Blvd., Nashville, Tenn., has been formed as a new division of General Shoe Corp. This new company will take over all of the industrial adhesive business of S. & F. Chemical Co.

Alimentos 7 Concentrados Archer, S. A., has been formed by Archer-Daniels-Midland Co., Minneapolis, Minn., and a group of Mexico City industrialists to manufacture and market Archer formula feeds in the Republic of Mexico.

Tubular Lining Corp., Houston, Tex., has been formed to specialize in the application of corrosion-resistant plastic linings to the interior of oil field tubing.

Nihon Rayonier Kaisha has been formed in Japan by Rayonier Inc., a New York cellulose producer, to represent Ray-

FIRMS . . .

onier's interests in the Far East.

G. M. Wallace & Co., Denver, Colo., has been appointed Field Application Engineers for all Roots-Connersville products.

Bertold Wolff, Inc., 20 Dongan Place, New York 4, N. Y., has been formed as a new organization to counsel industrial firms on the profitable utilization of metallurgical and chemical wastes and tailings.

Hayden Metals, Inc., has been formed as a wholly-owned subsidiary of Hydrometals, Inc., by the merger of Hayden Metals, Inc., and Hydrometals, Inc., New York, N. Y.

Ojibway Development Ltd. has been formed by Canadian Salt Co., Ltd. and Canadian Rock Salt Co., Ltd. to handle disposition of a prime site for a waterfront industrial complex located on the Detroit River opposite River Rouge. The two companies originally made the land purchase for the purpose of extending, for future development, their underlying salt reserves in the area.

Quelcor of Cincinnati, Inc., has been formed by Quelcor, Inc., Chester, Pa. The new organization will extend Quelcor's activities in the field of corrosion resistant plastisols.

Latin American Paper & Chemical Group has been formed by W. R. Grace & Co., New York, N. Y.

Grain Elevator Warehouse Co. has been formed by National Chlorophyll & Chemical Corp. to build elevators for inert-gas storage of alfalfa.

Polymer Engineering & Development Corp. has been organized by Resin Research Laboratories, Newark, N. J., for the purpose of offering the complete service of pilot plant facilities, process development, engineering design and construction of resin and polymer plants.

CHEMICAL ENGINEERING

Reader Service

A. J. BABKOW, MANAGER C. J. ROHRBACH, EDITOR

January 1957

GUIDE TO TECHNICAL LITERATURE

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Chemicals

Catalysts......"Harshaw Catalysts . . . Made to Your Specifications" includes sections on: typical Harshaw catalysts and how they are used: catalytic chemicals supplied by Harshaw; etc.
82 *Harshaw Chem. Co.

Cellulose, Hydroxyethyl......Bulletin gives physical properties, net container contents, description of product, properties of cellosize films. Bulletin F-8544B available upon request.
384A Carbide & Carbon Chem.

Chemicals......Bulletin summarizes physical properties and applications of vinyl monomers, acetylenic alcohols, glycols and hydrocarbons, diteriary glycols, and nonionic surface active agents.
384B Air Reduction Chem. Co.

Chemicals ...... "Industrial Chemicals" contains up to date information on company's basic industrial products. Lists uses, physical and chemical properties, handling advice, etc.
384C Nitrogen Div. (AC&D).

Chemicals, Molybdenum......Bulletin gives details which will help industrial users select economical and convenient starting materials for current molybdenum chemical applications. Bulletin Ch-27.
384D Climax Molybdenum Co.

Chemicals, Organic ...... "Eastman Organic Chemicals List No. 40" is a 224 p. catalog and price list for more than 3,500 Eastman organic chemicals. Company makes catalog available upon request.
384E Eastman Kodak Co.

Chlorine......28 p. brochure, "How To Use Pittchlor," covers the use of chlorine as an effective germicide and sanitary agent for practically every type of application. Request your copy.
384F Columbia-Southern Chem.

Colors, Dry......Bulletin covers organic dry colors and inorganic dry colors (Cadmium and Iron Oxide). Recommended for applications requiring maximum heat and light stability. Bulletin 02-175-3-7-56.
384G Harwick Standard Chem. Co.

Dispersions, Colloidal......New brochure gives a compilation of current good practice in high-temperature lubrication with colloidal dispersions. Company makes Bulletin 423 available on request.
384H Acheson Colloids Co.

Dyes, Vat ...... Controlled particle size brings greatly improved working properties to each dye and highest quality end-results to each application. Bulletin and samples on request.
384I American Cyanamid Co.

Elastomers......Neoprene and Hypalon elastomers are used in improving products and cutting maintenance and replacement costs. "Neoprene Notebook" and "Facts about Hypalon."
333 *E. I. du Pont de Nemours.

Ethyl Silicate......Company manufactures and markets three commercial grades of ethyl silicate: tetraethyl orthosilicate, condensed ethyl silicate and ethyl silicate 40. Details in Bulletin F-8265A.
384J Carbide & Carbon Chem.

Fluorine......Fluorine has been tamed and harnessed by General Chemical for industrial use . . . by anyone, anywhere . . . without requiring captive plant facilities. Request "Fluorine."
117 *General Chemical Div.

Furfural......Furfural: selective solvent for refining petroleum fractions and rosin; extractive distillation agent for hydrocarbon separations; reactive solvent for many resins. Bulletin 204.
40-1 *Quaker Oats Co.

Glycerine......Company offers: 20 p. "Glycerine Alkyds Tailored to Need," 8 p. "Federal Specifications for Glycerine," 20 p. booklet on Glycerine properties and applications.
139 *Glycerine Producers' Assoc.

Glycerine......"Glycerine Properties and Uses" describes the chemical and physical properties and the many diverse industrial applications of glycerine. Request this handy reference.
384K Glycerine Producers' Assoc.

Greases......Two water-resistant extreme-pressure greases especially recommended for shock-loaded bearings are described in Sun Technical Bulletin 49. Made available upon request.
384L Sun Oil Co.

Latex......Bulletin describes properties of a new styrene-butadiene copolymer latex for use in the coating of printing papers. Marketed under DYLEX latex K-52. Bulletin C-6-239T.
384M Koppers Co.

Niacin......Folder gives general description of the applications of niacin for human nutrition, plant nutrition, animal nutrition, and for formulation of B-complex vitamin tablets. Bulletin T-102-56.
384N Koppers Co.

Paraffin, Chlorinated......Two uses for CP-40 chlorinated paraffin are: treated fabrics to prevent hot sparks from welding equipment from flying around; fire-retardant paints. Details.
50-1g *Hooker Electrochem. Co.

1, 5-Pentanediol......6 p. bulletin gives information on 1, 5-Pentanediol's properties, shipping data, chemical reactivity, and applications. Includes literature references. Bulletin F-40006.
384O Carbide & Carbon Chem.

Contents of This Issue . . .

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Plasticizers......Some of the properties of Flexol plasticizer 810 are: low volatility, improved low temperature properties, light color and minimum odor, stable to heat and light. Bul. F-40078.
385A Carbide & Carbon Chem.

Polystyrenes...... Evenglo polystyrenes were developed in answer to the demand for a strong, lightweight and economical material for use in lighting applications. Request Bulletin C-6-162.
385B Koppers Co.

Potash, Caustic......Offers: solid, flake, granular, broken, crushed, powder, walnut, at 90% strength; solid and flake, at 85% strength; liquid, low-chloride at 45% strength. Request bulletin.
50-1b *Hooker Electrochem. Co.

Powders, Metal......Bulletin covers description, specifications, properties and uses of metal powders. These powders meet the exacting requirements of many diversified applications. Bul. 561.
385C Metals Disintegrating Co.

Preventers & Removers, Scale...... KETONE utilizes best features of polymerized phosphates and amino acid chelates to inhibit scale formation and dissolve and remove scale deposits. Tech. Bulletin.
B416 *United Chem. Corp.

Rauwolfia......"Rauwolfia and Its Alkaloids" is a compilation of approximately 800 references from domestic and foreign journals. Covers fields of chemistry, pharmacology, therapeutic uses.
385D S. B. Penick & Co.

Resins, Cycolac......Report on injection molding of Cycolac resins covers characteristics, drying, molds and gating, molding temperatures, ram operation, molded properties. Bulletin CY-3.
385E Marbon Chemical Div.

Resins, Formaldehyde......Dimethyl hydantoin formaldehyde resin is a waterwhite resin having an initial softening point of approximately 60°C. Dissolves readily in water. Sample and Bulletin.
385F Glyco Products Co.

Resins Geon Solution......Geon polyvinyl resins designed for resin solution application—to provide thin, economical coatings on wood, metal, and other materials. "Geon Solution Resins."
9 *B. F. Goodrich Chem. Co.

Resins, Piccolyte......Some of Piccolyte's advantages are: pale color, stable and non-yellowing, soluble in lowcost petroleum solvents, low cost. Condensed catalog available upon request.
385G Harwick Standard Chem. Co.

Resins, Solution......New catalog, "Firestone Exon Solution Resins," binds together bulletins concerning each of the six Exon vinyl chloride resins for solution coatings. Request your copy.
385H Firestone Plastics Co.

* From advertisement, this issue

LITERATURE . . .

Soda, Caustic......"Caustic Soda Engineering and Handling Guide" presents useful information on every phase of caustic soda handling. Offers graphs, charts and tables. Request Bulletin 102.
50-1a *Hooker Electrochem. Co.

Soda, Caustic......Caustic Soda Handling Chart includes information on: how to use caustic soda safely; personal protective equipment; and first aid treatment. Chart available on request.
386A Food Machy. & Chem. Corp.

Soda, Caustic......"Caustic Soda Buyer's Guide" contains helpful facts on economics of 50% & 73% solutions; other forms of caustic soda; capacities of tank cars & other containers; useful shipping data; etc.
386B *Hooker Electrochem. Co.

Sodium Benzoate......Hooker flake is just thick enough to stay in one piece without dusting during handling, just thin enough to dissolve rapidly as it settles. Request technical data sheet.
50-1e *Hooker Electrochem. Co.

Sodium Lauryl Sulphate......Technical bulletin describes properties of dustless sodium lauryl sulphate in needle form ("Solasol" needles). Needles offer greater emulsion stability.
386C Aceto Chemical Co.

Sodium m-Silicate......Valuable data on Drymet anhydrous—the most highly concentrated form of sodium m-silicate. Drymet File Folder contains technical data and suggested formulations.
B414 *Cowles Chem. Co.

Sodium o-Silicate......Folder, "Heavy Duty Industrial Cleaner," describes sodium orthosilicate. Levels of pH are plotted to show comparison of various alkalis at given % concentrations.
386D Philadelphia Quartz Co.

Sodium Succinate......"Sodium Succinate as an Adjunct in Psychiatric Therapy" describes clinical studies in which sodium succinate has been used alone and in combination with other drugs.
386E N. Y. Quinine & Chem. Wks.

Sodium Sulfide......The clean, strong flakes dissolve right into process, even without stirring. No waiting-no decanting. For information on Hooker's sodium sulfide, request Data Sheet.
50-1c *Hooker Electrochem. Co.

* From advertisement this issue

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Solvents......Cellosolve and Carbitol Solvents for soluble oils, wood stains, lacquers, printing inks, dye pastes, hydraulic fluids, perfumes and plasticizers are covered in Bulletin F-4765C.
387A Carbide & Carbon Chem.

Solvents......Company makes available any type of solvent you need—ketones, esters, alcohols, and glycol-ethers. Offers 14 Flexol plasticizers for all types of coating applications. Solvent Selector.
387B Carbide & Carbon Chem.

Sterilants, Soil......8 p. brochure describes how soil fumigation increases yields of many crops. Outlines methods of fumigating soil by applying temporary soil sterilant, Vapam.
387C Stauffer Chem. Co.

Construction Materials

Adhesives......Company offers technical bulletin on adhesives for "Mylar" polyester film. Contains complete descriptions with tables of six adhesives for "Mylar". Request your copy.
387D E. I. du Pont de Nemours.

Adhesives, Bonding......Bulletin covers function, composition, properties, consistency, application and advantages of Thixon NB rubber-to-metal bonding adhesive.Bulletin 03-9-4-9-56.
387E Harwick Standard Chem. Co.

Alloys......Hastelloy alloy B is resistant to hydrogen chloride gas at high temperatures, wet or dry. Has strength properties comparable to high-alloy steel. Request Hastelloy Booklet.
269 *Haynes Stellite Co.

Cements, Air Setting......Bulletin describes use of Crystolon RC 2351 Air Setting Cement. Tells how to mix and apply, either by hand or by spraying, this highly refractory cement.
387F Norton Co.

Chains......Bulletin describes Accoloy X-Weld 125 Chain, the latest major development in the art of welding chain and said to resist bending, breaking, and kinking. Request Bulletin DH-319.
387G American Chain & Cable Co.

Coatings, Ceramic......Bulletin describes Molcote, metallized ceramic coating. Gives details on applications, cleaning and plating, soldering and ordering procedures. Details in Bulletin 1155.
387H Frenchtown Porcelain Co.

Coatings, Protective......Catalog describes Amercoat protective coating systems for corrosion control. Outlines corrosion control services: assistance in selection, help write specifications, etc.
273 *Amercoat Corp.

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LITERATURE . . .

Coatings, Protective......Leaflet outlines protective coatings designed to improve the appearance, prolong the life, and ease maintenance of large floor areas. Request your copy of 8 p. pamphlet.
388A Chem. Specialties Mfgs.'

Concrete......"Concrete from Coral" contains two articles reprinted from Civil Engineering by D. Lee Narver..."Coral for Aggregate" and "Sea water for concrete." Request your copy.
388B Holmes & Narver, Inc.

Fabrication, Plate......Plate fabrication and erection of vessels, tanks, towers, odd and intricately designed chemical equipment . . . to any size . . . of any material. Complete details in Catalog 54B.
16 *Hammond Iron Works.

Floor Repairs, Concrete......6 p. folder describes Stonhard Stonpach, a specially formulated material for patching or overlaying concrete floors ruined by acids, grease, oil, etc.
388C Stonhard Co.

Insulating Materials......Technical report gives details on Irrathene (R) irradiated polyethylene, a unique insulating material. Company makes complete information available in Brochure CDD-I-2.
388D General Electric Co.

Insulating Materials......Basaltwool is an amazing new fibrous material, made from Basalt volcanic rock, possessing remarkable acoustic and heat insulating properties. Request 4 p. brochure.
388E Thermo-Sound Products.

Insulation, Industrial......No matter where your insulation job may be—Armstrong can give you efficient, well-integrated service from original specs to final installations. Booklets describe full line.
81 *Armstrong Cork Co.

Insulations, Molded Pipe......Kaytherm, a new wide temperature range molded insulation, has been designed for use on steam and heated process piping. Company offers additional information.
388F Keasbey & Mattison Co.

Insulators, Thermocouple......Bulletin illustrates and describes complete line of Serv-Rite thermocouple insulators. Lists dimensions, sizes, and types available. Request Bulletin 300-56.
388G Claud S. Gordon Co.

Linings, Corrosion - Resistant...... Company offers complete design, installation and maintenance of corrosion-resistant linings and tile tanks. Bulletin covers construction materials. Bul. A-153.
304 Stebbins Engrg. & Mfg. Co.

Metals......Kennametal is available in many standard forms, in addition to special shapes and parts, such as: rectangular blanks, discs, rods, tubes, flats, balls, rings. Bulletins B-111-A and B-222.
387 *Kennametal, Inc.

* From advertisement this issue

Neoprene......Neoprene Notebook covers resistance, neoprene flexible connectors for karbate pumps, process equipment expansion joints, electrical splicing tape, etc. See Neoprene Notebook 70.
389A E. I. du Pont de Nemours.

Paints......"Painting Bulletin" reports results of paint testing, abstracts of pertinent technical articles, investigations of paint failures, and reports of successful paint performances.
389B Steel Structures Painting.

Plastics......"Plastics Weldor and Fabricator" highlights the subject of anti-corrosion polyethylene coatings, and how such coatings may be applies to a wide variety of metal fabrications.
389C American Agile Corp.

Plastics......"Plastics for the Laboratory" lists over 60 items made from polyethylene. Also describes tubing made from plasticized polyvinyl chloride and sponge made from polyurethane.
389D Nalge Co.

Plastics......"Glossary of Plastics Terms" lists some 85 definitions, including terms such as bonding strength, center expansion, delamination, flexural strength, postforming, and thermo plastic.
389E Richardson Co.

Refractory Grain......"Norton Refractory Grain," offers many charts, tables and photographs in color—a wealth of information on nature, performance, and application of refractory grains.
93 Norton Co.

Rubbers, Silicone......"Lighting Selector" facilitates a rapid, accurate choice of the proper silicone compound or gum in the rapidly growing family of synthetic elastomers. See Bulletin AD 24E.
389F General Electric Co.

Steels, Plastic......Devcon, the plastic steel, is a combination of 80% steel and 20% plastic. Used to build up the inside of corroded pumps and valves, and repair leaking tanks. Bulletin.
389G Devcon Corp.

Steels, Rubber-Lined......Ace rubber-lined steel . . . strength & pressures of steel plus chemical resistance of hard rubber. Excellent for alkalis, most inorganic acids, etc. Bulletin CE-52.
317c *American Hard Rubber Co.

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Electrical & Mechanical

Batteries....Bulletin describes Gould Super Dreadnaught batteries. Gives details of battery construction, including Tite-Seal posts, basic Z grids, rubber separators, etc. Bul. GB 1668-B.
390A Gould-National Batteries.

Capacitors, Disc.....TinyMIKE "C"s are designed to provide linear capacitance change to correct for temperature drift of other circuit elements. For complete details, see Catalog 616.
390B Cornell-Dubilier Elec. Corp.

Casters & Wheels.....Featuring Darnelloprene treads (a soft resilient Neoprene rubber compound) . . . casters offer ease of movement, quietness, and protection for floors. See Manual for details.
R421 *Darnell Corp.

Drives, Fan......Bulletin describes hydraulic fan drive for air-cooled heat exchangers and cooling towers. Includes details on IMO motors and pumps that make up the fan-drive unit. Bulletin 3009.
390C De Laval Steam Turbine Co.

Drives, Shaft Mounted......Falk Shaft Mounted Drives furnish the economical solution to problems of efficient speed reduction in a limited space. Company makes details available in Bulletin 7101.
86 *Falk Corp.

Drives, Worm Gear......Cleveland Worm Gearing affords advantages for practically any power job. Steel worm on bronze gear reduces motor speed evenly, efficiently, and quietly. Catalog 400.
12 *Cleveland Worm & Gear Co.

Gaskets & Adaptors......Company offers literature on Jacketed Gasket, Type 1-339 WA, Chemiseal Snap-on Type 820 Gaskets and Chemiseal Adaptors No. 2-CRS. Request Bulletin TG-953.
289a *U. S. Gasket Co.

Motors.....Integrated field coils plus Silco-Flex insulation provide superior motor protection . . . under any operating conditions. Request Coil Bulletin 05R8525 and Insulation Bulletin 05R8341.
36-7 *Allis-Chalmers Mfg. Co.

* From advertisement, this issue

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You can get any publication in this literature listing by circling its key number on the Reader Service Post Card (inside back cover). Replies will reach you direct from the manufacturers.

Motors......Bulletin decribes latest design features of totally-enclosed, fan-cooled motors in NEMA rerated ratings of ½ to 30 hp and in non-rerated ratings of ½ to 100 hp. Bulletin 51B7225D.
391A Allis-Chalmers Mfg. Co.

Motors, Synduction......Provide dependable constant speed, simplicity of operation and low first cost in a variety of industrial applications requiring 40 hp and below. Bulletin 51B8440.
193 *Allis-Chalmers Mfg. Co.

Packings, Braided......Advantages of Lattice-Braid packings are: unified structure gives greater strength; no disintegration; less gland adjustment; unusual flexibility. See Folder AD-131.
30-1 *Garlock Packing Co.

Packings, Mechanical......24 p. condensed catalog on mechanical packings contains 246 types for every service in industry. Features recent packing developments. For details, see Catalog 56.
391B U. S. Gasket Co.

Rectifiers......New miniature, 10-kilowatt silicon rectifiers are capable of operation in an ambient temperature range of from -65°C. to 200°C. Additional information is available upon request.
391C General Electric Co.

Reducers.....Chemiseal Reducers No. 3-CRS are one piece assemblies, designed to connect unlike pipe sizes with minimum length requirements. Standard sizes from 1" to 6". Bulletin 3-CRS.
289c *U. S. Gasket Co.

Reducers, Speed......New brochure covers three styles of speed reduction: integral gear motors, speed reducers with separate motors, and speed reducers alone. Details in Bulletin 191-50M-8-56.
391D Sterling Electric Motors.

Relays...... Specification Sheet describes Hagan Model '3-15' Ratio Relay for the pneumatic control field. Includes operation, description of features, construction specifications, etc. Sheet SP-4315.
391E Hagan Corp.

Seals, Hermetic......Bulletin describes Series N-1000 Hexseals featuring high pressure switch boots used to replace standard panel mounting hardware on toggle switches. See Bulletin Hex-7.
391F Automatic & Precision Mfg.

Seals, Mechanical.......Combining chemically impervious teflon with a balanced bellows design—Chemiseal mechanical seals last longer & give unsurpassed performance. Bulletin MS-1155.
327 *U. S. Gasket Co.

Starters, Motor......You can install an Allen-Bradley starter and forget it. Only one moving part—the solenoid plunger. No leakages, bearings, pins, or pivots to rust and stick. Catalog.
191 *Allen-Bradley Co.

* From advertisement, this issue

Tool Sets......Company assembles special tool sets for a wide range of industries including automotive, aviation, construction, chemical, petroleum and railroad. Request Catalog V.
295 *Snap-On Tools Corp.

Tools, Cutting......Catalog describes aluminum oxide cutting metals, tool tips, throw-away inserts, cylinders and other machine turning and cutting tools. Includes technical data and applications.
392A Metal Carbides Corp.

Tools, Hand......Company offers a new precision hand tool to prepare pump stuffing boxes for mechanical seal installation. Assures proper mechanical seal performance. Request information.
392B Byron Jackson Co.

Tools, Hand......Catalog covers Parker hand tools—tube cutters, flarers, benders—also bench mounted benders, power flarer, straight thread tapping, etc. Catalog 1140.
392C Parker Appliance Co.

Transformers, Control....Publication gives voltage ratings, frequency, frame size, weight, price and specification data on auto transformers, control panel and machine-tool transformers.
392D General Electric Co.

Transformers, Variable......Powerstat line offers standard air-cooled type transformers for manually-operated or motor-driven duty; oil-cooled models; explosion-proof units. Bulletin P856G.
179 *Superior Electric Co.

Handling & Packaging

Bins, Bulk Material......Vertical or horizontal styles are available for any plant layout. To improve your plant's bulk storage and handling, company offers Bulletins 529 and 549.
84f *Day Co.

Boxes, Corrugated....."How to Engineer Corrugated Shipping Boxes" describes each step in the development of the modern shipper including study of product to be packaged, original engineering.
392E Hinde & Dauch.

* From advertisement this issue

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Cleaners, Belt......Protects and extends the life of valuable belts. Adjustable to any width . . . easily installed . . . no moving parts . . . no power drive required. Request Bulletin 1754.
62b *Stephens-Adamson Mfg. Co.

Conveyors......Catalog covers four patented products: Magnavator, Tube-Veyor, Chip-A-Way and Welded Tube. Also covers custom built conveyor equipment. Details are in Catalog 500.
393A Prab Conveyors.

Conveyors, Chain......Bulletin describes low cost overhead conveyor. Lists features of the lightweight and flexible conveyor, and illustrates several of its uses. request your copy.
393B Chainveyor Corp.

Conveyors, Multi-Tier......If you heat, cool, dry, freeze, bake, store, pasteurize or cure, you will be interested in Continuous Multi-Tier Processing for industry. For details, Bulletin 55-12.
87 *J. W. Greer Co.

Conveyors, Wheel......Catalog tells how Live Rail can be used to move, store or unload large and small packages ,parts in process—most objects with smooth, flat bottoms. Cat. LR-56.
393C Alvey-Ferguson Co.

Cylinders, Compressed Gas....... Lightweight Hackney cylinders save freight . . . help you tackle higher shipping costs. Offer rigid inspection, uniformity, durability. Specification sheets.
14 *Pressed Steel Tank Co.

Dockboards, Automatic......Manufacturers of Hi-Lo Automatic Dockboards have redesigned and simplified their units for greater ease of installation, smoothness of operation and safety. Details.
393D Kelley Co.

Dragscrapers......One operator; all highly machined parts; when parts are replaced, the machine is restored to practically new condition. Company makes complete details available in Catalog E.
286 *Sauerman Bros.

Feeders, Wet Reagent.....Accurately meter minute quantities of liquid from 0 cc to 2000 cc per minute. Float valve in tank permits connection of feeder to bulk storage device. Bulletin F6-B9.
318e *Denver Equipment Co.

Holdbacks......Mounts on headshafts of belt conveyors and bucket elevators to prevent reversal under load in case of power failure. Safeguards personnel and equipment. Request Bulletin 155.
62c *Stephens-Adamson Mfg. Co.

Idlers, Conveyors......Idlers' quality features assure dependable, full-capacity conveying . . . spun end, one piece rollers; permanently sealed; pre-lubricated; quick-change rollers. Bulletin 355.
62a *Stephens-Adamson Mfg. Co.

* From advertisement, this issue

Mixer-Unloader Units....New A-S-H Type B mixer-unloader removes ash or other dry material from storage bins, mixes it with water and discharges it into waiting trucks or rail cars. Data Sheet Uc.
394A Allen-Sherman-Hoff Co.

Scales, Fertilizer...... Richardson fertilizer scale bags 20 sacks a minute. This scale is accurate to ± four ounces on 80 lb. weighings. Company offers details on its HA-39 fertilizer scale.
394B Richardson Scale Co.

Tanks, Aluminum, Welded......For storage, pressure vessels and processing equipment built to ASME Code specifications to meet all insurance requirements. Company makes available on request, "Tank Talks."
T428 *R. D. Cole Mfg. Co.

Tractor-Shovels......The HA "Payloader" & the larger model HAH do the work of 4 previous units. Ideal for any bulk materials you have to scoop-up, load or spread. Data.
28-9 *Frank G. Hough.

Tractor-Shovels......Bulletins cover two Payloader tractors shovels ...model HU with a capacity of 1¼ cu. yd., 4000 lbs. @ 4 MPH and model HH with a capacity of 1¾ cu. yd., 5500 lbs. @ 4 MPH.
394C Frank G. Hough Co.

Trucks, Fork Lift......FT series fork lift truck starts, steers, drives and shifts like an automobile. Safest in the field . . . most advanced design . . . most serviceable Catalog BU-300-564.
13 Allis-Chalmers Mfg Co.

Trucks, Fork Lift.....Allis-Chalmers fork lift trucks cut costs in stevedoring. These trucks are completely safe for indoor hauling. Complete details in Case Study No. 16.
394D Allis-Chalmers Mfg. Co.

Trucks, Lift.....2500 lb. SpaceMaster Model JFTT 2.5 has been designed for extreme heavy duty operation...especially when the operation involves constant stopping and starting. Circular 33-E.
394E Lewis-Shepard Products.

Trucks, Materials Handling....132 p. catalog on the Master Line of materials handling trucks describes in detail the many models of L-S trucks available. Indexed into five categories.
394F Lewis-Shepard Products.

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Trucks-Storage Racks......20 p. catalog describes full line of Floormaster Trucks and Loadmaster Storage Racks. Contains complete specifications and applications. Details are in Catalog 29-1.
395A Lewis-Shepard Products.

Heating & Cooling

Air Conditioning, Controlled Humidity......Method removes moisture from air by contact with a liquid in a small spray chamber. Heating or cooling done as separate function. Bulletins 112 and 121.
328 *Niagara Blower Co.

Coils, Heating & Cooling......Stainless—Continuous plate type with smooth drawn ferrules pressure-expanded to produce positive mechanical and thermal bond between tube & fin. Data.
73a *Marlo Coil Co.

Condensers, Evaporative......Stainless—3—150 tons. Suitable for indoor or outdoor location. All prime surface condensing coil. Available to your specifications. Request information.
73b *Marlo Coil Co.

Coolers, Oil......"WIO" Oil Coolers have application on all types of diesel and gasoline engines, hydraulic equipment, air compressors, machine shop coolant systems, etc. See 8 p. bulletin.
395B Heat-X, Inc.

Evaporators.......Quality products now being produced at low cost are: biochemicals; insulin—higher quality, potency, yield; vanilla extract—high total solids with only small alcohol loss. Bul. 300.
B428 *Mojonnier Bros. Co.

Evaporators......"Evaporators For Recovery of Mercerizing Caustic" gives information on design, application, operation and construction of this type of evaporator. Details are in Bulletin SW-201.
395C Swenson Evaporator Co.

Evaporators, Film.......Company offers wiped film evaporator in 2" glass model and in these diameters of stainless steel: 12", 24", 36", 48" and 60". Available in monel, hasteloy, etc. Data Sheet 39.
24-5a Pfaudler Co.

Generators, Steam.......Modulatic Steam Generator is clean, quiet, follows fluctuating load up or down with unmatched speed and accuracy—just set controls for the pressure you want. Booklet 586.
63 *Vapor Heating Corp.

Generators, Steam......Vogt steam generators are available in bent tube types and straight tube forged sectional header types for solid, liquid or gaseous fuels. Request product Bulletins.
243 *Henry Vogt Mach. Co.

* From advertisement, this issue

Heat Exchangers......."Flexible-standard" units are adaptable to vertical, inclined, or horizontal installation. Offer many features you look for in custom-built heat exchangers. See Bulletin 837.
4th Cov. *Pfaudler Co.

Heat Exchangers......Company offers new design service covering corrosion-resistant heat exchangers, chlorine coolers, falling film absorbers, and towers of all types. Design Service Bulletin.
396A Haveg Industries.

Heat Exchangers, Acid Resistant..... Important data on Swenson type of tube mounting, types of corrosion resistant materials available and advantages of neoprene ring gaskets in Bulletin SW-200.
151 *Swenson Evaporator Co.

Heat Exchangers, Fin-Tube......Bulletin describes excellent heat-transfer characteristics of Alco longitudinal fin tubes. Includes a table of dimensions, etc. Details are in Bulletin FH-3.
396B Alco Products.

Heat Treatment......Heat Treat Review, Vol.7, No.2, includes article on "Basic Principles of Quality Gas Carburizing." Simplicity and accuracy of process are graphically illustrated.
396C Surface Combustion Corp.

Heaters, Circulation.......Bulletin presents Case Studies concerning the use of Chromalox electric heaters. Includes cases of the heating of fuel oils, steam, air & other gases. Bulletin F-1587.
90 Edwin L. Wiegand Co.

Heaters, Unit & Blast.....Catalog describes Grid Cast Iron steam heat transfer surface unit heaters, blast heaters and radiators. Company makes details available in Catalog GP No. 956.
396D D. J. Murray Mfg. Co.

Heating Systems, Dowtherm.....Descriptive information on Dowtherm heating systems for processes requiring precision control of high constant temperatures at low pressures, in Bulletin ID-54-5.
245 *Foster Wheeler Corp.

Ovens......Brochure describes Blue M power-o-matic mechanical convection ovens, lab-heat muffle furnaces, stabil-therm gravity type ovens, stabil-therm mechanical recirculating, etc. Bul. 5660.
396E Blue M Electric Co.

Ovens, Dielectric......Bulletin describes newest method of heating, baking, drying or curing non-metallic, non-conductive material, dielectric, or electronic heating. Request Bulletin 56-E.
396F Young Bros. Co.

Recirculating Units......Brochure provides detailed technical data and description of the Standard Mayer Chil-er Recirculating Units. Covers complete specifications in chart form. See Bulletin Ch-3D.
396G Mayer Refrigerating.

* From advertisement this issue

Thermocouples, Miniature Gasket.... ..Fast, accurate skin temperature measurement with easily installed T-E Miniature Gasket Thermocouples. Choice of three temperature ranges. Bulletin 1-E.
B415 *Thermo-Elec. Co.

Thermo-Panels......Cost less & perform better—an improvement on pipe coils. Save space & heat or cool more efficiently. For use in heating & cooling of liquids, slurries, etc. Bulletins 355 & 256.
TL425 *Thermal-Panel Div.

Towers, Cooling......Stainless—2—150 tons. Suitable for indoor or outdoor location. Marlo heat transfer equipment now available to your specifications. Request further information.
73c *Marlo Coil Co.

Towers, Cooling......"Answers to 15 Questions about Pritchard Induced Draft Cooling Towers" gives valuable advice on factors to consider in choosing towers, tips on evaluating bids.
187 *J. F. Pritchard & Co.

Towers, Cooling....The "MTI" Cooling Tower is designed especially for industrial applications where process water temperatures are critical and must be accurately maintained. See Catalog 203.
397A Baltimore Aircoil Co.

Traps, Steam......44 p. book tells how to select traps for nearly every class of equipment; gives prices, physical data, service pressure ratings of Armstrong traps; etc. See Catalog J.
347 *Armstrong Machine Works.

Traps, Steam......New, helpful 8 p. bulletin deals exclusively with trapping steam tracer lines. Yarway ½" No. 20-A impulse steam trap is the right trap for steam tracer lines. Bulletin.
357 *Yarnall-Waring Co.

Washers, air......Stainless steel air washers custom built to your specifications for: washing, cleaning, humidifying, dehumidifying, heating, and cooling. Details on request.
73d *Marlo Coil Co.

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Instruments & Control

Analyzers, Gas......L&N Thermal Conductivity Gas Analyzers feature: accuracy, sensitivity, stability, fast response, interchangeable cells, etc. Complete details available in Folder ND46-91(2).
98 *Leeds & Northrup Co.

Analyzers, Gas & Liquid......Electronic infra-red analyzer is designed to fill the need for a moderately-priced instrument for most continuous-flow chemical analysis problems. See Bulletin 0705-2.
398A Mine Safety Appliances Co.

Analyzers, Oxygen......Beckman Oxygen Analyzers available for time-saving, accurate measurements of oxygen in your process or laboratory operations. Company offers information in Data File.
410 *Arnold O. Beckman.

Bridges, Impedance......Company offers information on their Impedance Bridge, Type LB-50 for making rapid, accurate measurements of all types of resistance, capacitance, etc. Catalog L2005.
398B Radio Corp. of America.

Comparators......Fully illustrated, 100 p. tells how to use pH and chlorine control for water supplies, process solutions, production processes in 34 basic industries. Covers complete line of comparators.
L424 *W. A. Taylor & Co.

Controllers, Level......Bulletin describes pheumatic level controller "Level-Trol." Includes principal of operation of displacement type float and illustrated construction. Bulletin F-4.
398C Fisher Governor Co.

Controllers, Pressure......Company offers information on the Norwalk Pressure Controller, including recommended uses, principles of operation, table of dimensions, etc. Bulletin No. 5000.
398D Norwalk Valve Co.

Controls, Moisture......New technical data sheet outlines an improved method of moisture control in natural gas streams. New method will improve system efficiency. Data Sheet EH-67-0.
398E Beckman Instruments.

Controls, Temperature.....Features: cuts initial control costs; costly production stoppages; control maintenance costs. Controls for gas, liquids & solids in —30°F. to 1200°F. ranges. Catalog CC.
399 *Partlow Corp.

Controls, Temperature......17 p. catalog presents company's line of remote bulb temperature controls . . . industrial, aircraft, marine, special purpose. Includes features, specifications, etc. Catalog 200.
306 *United Elec. Controls Co.

* From advertisement, this issue

Gages......For pressure, vacuum or compound service. There are no gears or teeth to wear out. Cam wiping action keeps contact points clean & smooth. Complete information in Catalog G-2.
313 *Helicoid Gage Div.

Gages, Liquid Level......Bulletin describes Truscale Remote Reading Liquid Level Gages with unique safety features. Red Flashed Truscale gives warning if too high or low. See Bulletin 291.
399A Jerguson Gage & Valve Co.

Gages & Valves, Electrically Heated......Bulletin gives details & illustrates new Jerguson valves & gages. Describes applications, variety of designs, construction, etc. Data Unit # 237.
399B Jerguson Gage & Valve Co.

Generators, Signal......Information offered on VHF Standard Signal Generator, Type Lg-23, for measurement of sensitivity, aligning & testing VHF communications equipment, etc. Catalog L4030.
399C Radio Corp. of America.

Indicators, Temperature......Information about L&N's portable, direct-reading thermocouple potentiometer indicators with automatic reference junction compensation in Data Sheet ND42-33(1).
399D Leeds & Northrup Co.

Instruments, Process......Bulletin describes process instruments manufactured by Beckman. Covers electrolytic hygrometer, L-B infrared analyzer, leak detector, etc. See Bulletin 491.
399E Beckman Instruments.

Meters......Bulletin describes over one-hundred measuring, transmitting, receiving, recording, & indicating instruments & control components for power & process applications. Bulletin G15-1.
399F Bailey Meter Co.

Meters, Flow......Catalog covers company's line of multi-stage, variable-area Flowrator meters. Includes sizing charts and complete dimension diagrams. For details, see Catalog 10-A-34.
399G Fischer & Porter Co.

Recorders......Offer valuable features: pre-calibrated plug-in receiver units; up to 4 pneumatic or electronic receivers—or 2 receivers & 2 integrators; etc. Request Product Specification E12-5.
96 *Bailey Meter Co.

* From advertisement, this issue

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LITERATURE . . .

Retractometers......Offers new process refractometer, designed to monitor continuously the refractive index of liquid process streams in refineries and chemical plants. CEC Bulletin 1833.
400A Consolidated Electrodynamics

Regulators ...... Pneumatically-adjusted direct-acting flow rate regulators for automatic proportioning of two or more flows, remote adjustment of liquid flow rates. Details in Form 562.
400B W. A. Kates Co.

Spectrophotometers......Bulletin features articles about infrared spectroscopy and data processing, and subjects of interest to the analytical and process instrumentation fields. Bulletin 18.
400C Beckman Instruments.

Thermometers......Data sheet describes twelve-channel dial thermometer with flashlight battery powered circuit & thermistor probes. Interchangeable probe types listed.
400D Arthur S. LaPine & Co.

Thermostats......Catalog offers data on Snap-Action Thermostats. Lists physical and performance specifications for many types of snap-action, locally-adjustable thermostats. Catalog MC-120B.
400E Fenwal, Inc.

Transformers, Variable ...... New types 136 and 236 Powerstat variable transformers presented in Bulletin P354. Type 10 Powerstat variable transformer covered in Bulletin P252. Also price list.
400F Superior Electric Co.

Pipe, Fittings, Valves

Coils, Smooth - Fin.......Aerofin smooth-fin coils offer you: greater heat transfer per sq. ft. of face area; lower airway resistance—less power per c.f.m. For details, see Bulletin S-55.
390 *Aerofin Corp.

Fittings & Flanges, Welding...... Folder describes the full line of carbon, alloy and stainless steel seamless welding fittings and forged steel flanges handled by B&W. Request Folder FB-502.
400G Babcock & Wilcox Co.

* From advertisement, this issue

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Fittings, Stainless Steel......Speedline fittings simplify pipeline design. Details of the greater design flexibility possible with Speedline fittings . . . at lower cost . . . available in catalog.
TL423 *Horace T. Potts Co.

Flanges, Taper Face......Lightweight and tapered face permit good seals with reduced boltloading on valve or pump flanges. Lighter neck speeds up welding to pipe. Details in Bulletin.
328A-B *Tube Turns.

Hose, Metal, Flexible......Produced in various alloys of stainless steel —in monel, bronze, and carbon steel. Ideal for use with high temperature and high pressure corrosive gases. Bulletin 21-A.
79 *Atlantic Metal Hose Co.

Hose, Metal, Flexible.....Engineered and manufactured to absorb the costly beating your piping system is now taking . . . efficiently and economically. Details made available in Bul. IND 4.
312 *Packless Metal Hose.

Joints & Couplings......For maximum safety . . . specify R/M "Teflon" Expansion Joints and Flexible Couplings in your critical fluid lines. Details contained in booklet on R/M "Teflon" Accessories.
396 *Raybestos-Manhattan.

Joints & Couplings......Teflon expansion joints and flexible couplings absorb shock, vibration, thermal expansion and contraction. Connect unlike piping ends and nozzles. Bulletin EJ-1155.
289b *U. S. Gasket Co.

Joints, Expansion......Adsco Expansion Joints will do a better job because of . . . less heat loss, less pressure drop, less space, lower cost. Details in Bulletins 54-10PR and 35-51-PR.
331 *American District Steam Div.

Nozzles, Spray......Capacity of new 2-U-Veejet nozzle ranges from 73 GPM at 15 psi to 330 GPM at 300 psi. Supplied in choice of two types of spray angles. Details available in Data Sheet 6868.
401A Spraying Systems Co.

Pipe, Aluminum......Reynolds aluminum pipe features: lower cost, light weight, strong-seamless, non-rusting, fast installation, flexibility, standard sizes-highest quality. Bulletin C3b-10-2560.
401B Reynolds Metals Co.

Pipe & Fittings, Glass......Glass Pipe & Fittings for full-scale production operations. Strengthened by end-tempering & feature corrosion-resistance, non-contamination, etc. Catalogs EA-1 & EA-3 offer full data.
266-7a *Corning Glass Wks.

Pipe & Fittings, Nickel-Lined......8 p. brochure features fabrication techniques and technical information on applications of Bart Lectro-Clad nickel-lined pipe and fittings.
401C Bart Mfg. Corp.

* From advertisement, this issue

Pipe-Fittings-Valves . . . . . . Engineering catalog gives complete data about the Van-Cor line of unplasticized polyvinyl chloride pipe, fittings and valves. Covers both types of Van-Cor.
402A Colonial Plastics Mfg. Co.

Pipe Installation, Glass . . . . . . Pipe is easy to install & low in installed cost compared with other corrosion-resistant materials. Available in 6 standard sizes from 1- to 6-inch. I.D. inclusive. Installation Manual PE-3.
266-7b *Corning Glass Wks.

Pipe, Plastic . . . . . . Ace Rivivor is a new rigid threaded plastic pipe with good aging & high impact strength. Not affected by most inorganic acids & alkalis. Request Bulletin CE-56.
316 *American Hard Rubber Co.

Pipe, Plastic . . . . . . Polyvinyl Chloride is the unparalleled material for plastic pipe. It's a high quality unplasticized-rigid pipe designed to do a better job than any other material. Bulletin 24.
185 *U. S. Steel Corp.

Pipe, Polyethylene, Flexible . . . . . . Bulletin includes applications for Supplex pipe, sizes of standard pipe and fittings, installation instructions, technical properties, etc. Request Bulletin CE-57.
402B American Hard Rubber Co.

Pipe, Rigid . . . . . . Koroseal rigid pipe is exceptionally easy to install. Can be threaded with standard pipe threading equipment, quickly joined to Koroseal valves and fittings. Booklet.
177 *B. F. Goodrich Industrial Prods.

Pipe-Tubes-Fittings . . . . . . Folder on B&W Croloy 5 includes technical information on pipe, tubes and welding fittings. Company makes further information available in Folder TDC-146A.
402C Babcock & Wilcox Co.

Rings, Raschig & Lessig . . . . . . Metallo—prime manufacturers of Raschig and Lessig Rings . . . from inventory or custom designed to your specifications. Complete information, specifications, prices.
B413 *Metallo Gasket Co.

Tubes, Ceramic Protecting . . . . . . Bulletin illustrates and describes Serv-Rite line of ceramic protecting tubes. Lists various sizes available in different materials and prices. Bulletin 1000-56.
402D Claud S. Gordon Co.

Tubes, Condenser . . . . Wolverine bends condenser tubes to your specifications—ships them in disposable box-type pallets—ready for direct insertion into your heat exchanger or condenser. Catalog.
176A-B *Wolverine Tube Div.

Tubing . . . . . . Bulletin lists 121 metals and alloys from which the firm produces its standard and special small diameter tubing. Company makes further details available in Data Memorandum No. 1.
402E Superior Tube Co.

* From advertisement, this issue

Tubing, Instrument......Solves your corrosion problems for instrument tubing . . . Crescent Armored Multitube. Available in lengths to 1000 feet in from 2 to 19 tubes. Details in Bulletin 356-H.
T412 *Crescent Insulated Wire & Cable.

Tubing, Plastic, Flexible......28 p. booklet covers each of the many Tygon Tubing formulations individually and in technical detail. Presents applications and limitations. See Bulletin T-97.
104 U. S. Stoneware Co.

Valves......"Sentry" Models 1200, 1700, 1800, & 3000 are patented quick-closing latch type & quick-opening piston type. All are full flow valves. For full information request Bulletin 500.
89 *Coppus Engineering Corp.

Valves......There's an Ace hard rubber, rubber-lined, or plastic-lined valve for every corrosion application. Diaphragm, gate and check types. Lists chemicals handled in Bulletin CE-52.
317b *American Hard Rubber Co.

Valves......Vogt GP Valves are available in a complete range of sizes from ¼" to 2" and rated 800 pounds at 850°F. and 2000 pounds at 100°F. Request Supplement No. 1 to Catalog F-9.
202 *Henry Vogt Machine Co.

Valves, Butterfly......In this new Catalog you get dimensions, layout drawings, specifications and materials for all pressure ratings of R-S Butterfly Valves that are now standardized. Catalog 160.
389 *S. Morgan Smith Co.

Valves, Check......Durable Check Valves are low in cost while being high in quality. Available in seven standard line sizes, from ⅜" to 2". Complete details available in Bulletin CE-17.
314 *Durabla Mfg. Co.

Valves, Check.......Multi-purpose check valve outperforms—outwears other valves—costs less to maintain. Produced in numerous metals and alloys as well as polyvinyl chloride. Bulletin available.
94 *Techno Corp.

Valves, Control......12 p. booklet gives details on construction and operating characteristics of Series LB control valves, available in sizes 1" through 4". Details available in Bulletin LB-2.
403A Conoflow Corp.

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LITERATURE . . .

Valves, Diaphragm......Catalog describes Hills-McCanna diaphragm valves in terms of their advantages, applications and specifications. Shows three basic types of valve operations. Catalog 100.
404A Hills-McCanna Co.

Valves, Gas......Fireye Series 81L automatic gas valves are fast closing and slow opening. Feature compression-type spring that automatically shuts off fuel in 0.8 of a second. Bulletin CV-32.
404B Electronics Corp. of America.

Valves, Gate....Stand up perfectly under conditions ranging from 380 psi at 1000°F to 2000 psi at 100°F. Use Chapman List 990 valves for higher pressures. Full details available in Catalog 10.
60 *Chapman Valve Mfg. Co.

Valves, Globe......Company offers circular on two pressure classes of Lunkenheimer LQ600 Bronze Globe Valves, for a wide variety of services from normal to exceptionally severe. Circular 602-2.
404C Lunkenheimer Co.

Valves, Plug.....Choose from Homestead Lever-Seald Plug Valves cast of metals and alloys to specification in sizes from 1" to 12"; for pressures from vacuum to 1500 lbs. Reference Book 39-3.
103 *Homestead Valve Mfg. Co.

Valves, Reducing & Relief......Company offers combination pressure reducing and relief valve for air, gas, oil or water service that operates on initial pressures to 4000 psi. See Bulletin F-56.
404D Atlas Valve Co.

Valves, Solenoid......ASCO Valves adapt to handle almost any corrosive gas or liquid. Standard, watertight, or explosion-proof enclosures may be specified. "Solenoid Valves for Corrosive Applications."
287 *Automatic Switch Co.

Valves, Spray......Bulletin provides complete information on Farval spray lubrication systems for open gearing and slide surfaces. Offers descriptions of manual and automatic systems. Bulletin 60-A.
404E Farval Corp.

Process Equipment

Agitating Equipment.....Use Nettco Flomix to combine liquids & solids as they flow through a pipe line. Company makes available bulletins & data. Bulletin Nos. 531, 551 & 532.
76 *New England Tank & Tower.

Agitators, Side Entering......On a side entering mixer either stuffing box or mechanical seal can readily be converted to the other, if desired. Company makes details available in Bulletin 72-A.
285 *International Engineering.

* From advertisement, this issue

Bellows......Chemically inert bellows made of teflon have these features: chemically inert, lifelong flexibility, outstanding electro-chemical properties. See, "The Best in Teflon."
287 — *Crane Packing Co.

Blenders, Dry-Batch......Speed up production with 4-way mixing; shorten shut-downs with "open-door" design. Batches from 500 to 40,000 lbs. Company makes bulletin available for details.
69 — *Sturtevant Mill Co.

Blenders, Twin Shell......Standard model Twin Shell for gentle mixing action, "Intensifier" for difficult-to-blend materials, "Liquid-Solids" blender for blending liquids into dry materials. Catalog 14.
155 — *Patterson-Kelley Co.

Cartridges, Filter......Bulletin describes the Hilco filter cartridge Type FFC, for lubricating and straight mineral oil filtration, made of Hilite, the improved fullers earth. Bulletin F-152-1.
405A — Hilliard Corp.

Cleaning Systems......Bulletin, "The Dorrco Monorake," describes the design, types & sizes, operation & advantages of this mechanism for cleaning rectangular sedimentation basins. Bulletin 6001-R.
405B — Dorr-Oliver.

Crushers......Bulletin describes company's Horizontal (Cylinder and Nut Type) Crusher. Also gives basic information, illustrations, specifications and construction details. Bulletin No. 129.
405C — Sprout, Waldron Co.

Crushers, Jaw......Cast, steel, frame, manganese jaw & check plates. Large diameter shafts reduce shaft deflection & thus increase life of roller bearings in bumper. Bulletin C12-B12.
318d — *Denver Equipment Co.

Disintegrators......Bulletin for the food & chemical process industries, deals with applications of disintegrators to fine or coarse disintegration and/or mixing of wet dry materials. Bulletin R-507.
405D — Rietz Mfg. Co.

Dissolvers......If your operation could profit by the use of high energy intensive dissolvers, or other equipment designed to increase the speed and efficiency of process operations, see Bulletin 236.
183 — *Dravo Corp.

* From advertisement, this issue

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LITERATURE . . .

Dryer-Blenders......Solid one-piece construction of inner vessel for maximum strength . . . no joints or clamps to break up the drying surface area. Complete details available in Data Sheet 26.
24-5c *Pfaudler Co.

Dryers.......Available in several types: direct heat, indirect heat, and steam tube. Let Deco engineers help solve your drying problem—no dryer problem too small or too large. Bulletin No. D4-B2.
318j *Denver Equipment Co.

Dryers......Help solve problems of drying air or other gases. Offer advantages: simplicity of operation & maintenance; low installation cost & minimum maintenance expense. Bulletin D-27.
101 *C. M. Kemp Mfg. Co.

Dryers......Compact machine introduces dry, heated air through ever-changing channels reaching entire surface of every particle. Stratification and segregation prevented. Book 2511.
17 *Link-Belt Co.

Dryers......Standard Hersey Dryers handle difficult drying jobs with trouble-free, efficient and economical service. Company makes full details available in Standard-Hersey bulletin.
125 *Standard Steel Corp.

Dryers......"Swenson Spray Drying Equipment" contains information on spray drying equipment for producing high quality soluble coffee. Illustrates various sections of the dryer. Bulletin SW-400.
406A Swenson Evaporator Co.

Dryers, Vacuum......Faster, uniform heat transfer plus rapid vapor removal . . . means today's best in vacuum drying with the Patterson Conaform. Request detailed Bulletin 5611-1.
324 *Patterson Foundry & Mach.

Dust Collectors......With Pangborn dust collectors employees can work without respirators and protective clothing which would otherwise be necessary. "Out of the Realm of Dust."
315 *Pangborn Corp.

Dust Filters......28 p. book explains the distinguishing features of reverse jet filters. Contains schematic operating diagrams, performance curves for various types of dust. Bulletin No. 559.
84a Day Co.

Dust Filters......"Type RJ" dust filter is an economical, high efficiency, automatic-continuous dust filter which can be furnished for pressure or vacuum operation. Details in Bulletin 560.
84c *Day Co.

Filter Cloth, Metallic......Newark metallic filter cloth is available in a variety of weaves in all malleable metals, and is adaptable to practically all types of filters. Data in Catalog "E."
319 *Newark Wire Cloth Co.

* From advertisement, this issue

Filter Leaf......New "RIM-LOK" Filter Leaf provides simple closure of metal filter cloth in leaf frame without use of rivets, bolts or solder. Made of any commercial alloy. Request Bulletin 561.
296 *Multi-Metal Wire Cloth Co.

Filters......Company offers almost infinite variety of filter types, discharge methods, valve designs, cake washing systems, dewatering devices, internal drainline arrangements, etc. Bulletins.
173 *Filtration Engineers.

Filters, Air......Multiple-media Multi-Pak air filter was specially designed to offer higher air cleaning efficiency, higher dust-holding capacity in a mechanical filter. Bulletin 237.
75 *American Air Filter Co.

Filters, Disc......Special patented design of segments in filters use both gravity & vacuum to give a drier filter cake. Drainage is complete & positive with no blowback. Details in Bulletin FG-B1.
318f *Denver Equipment Co.

Filters, Dust......The Dynaclone self-cleaning, flat-bag filter is the only unit which operates continuously without the need for auxiliary blowers to create reverse cleaning air. Booklet.
392 *W. W. Sly Mfg. Co.

Floats......Harris Floats for any liquid, for high pressures, for high temperatures. Catalog presents data on various sizes, types of floats, and suitable metals for different corrosive liquids, temperatures.
TL421 *Arthur Harris & Co.

Fluidizers......Company offers information on their Superior"Fluidizer", including principles of fluidization, installation, general operating instructions, maintenance information, etc.
407A Superior Separator Co.

Mills, Ball......A steel-head ball mill will suit your particular need. Five types of discharge trunnions. All-steel construction. Low initial cost due to quantity production. Bulletin B2-B13.
318b *Denver Equipment Co.

Mills, Ball.....Traylor grinding mills are offered in a wide variety of types including: ball, rod, compartment and tube mills for wet or dry . . . coarse or fine grinding. Bulletin 11-121.
34 *Traylor Engrg. & Mfg. Co.

* From advertisement, this issue

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Mills, Ball & Pebble......Valuable references give details on the Abbe Engineering series of mills for every range of work from small batch jobs to full scale plant production. Catalog Nos. 73 & 77.
398 *Abbe Engrg. Co.

Mills, Imp......Raymond imp mill is equipped to handle almost any combination of pulverizing, blending, classifying, conveying and/or drying operation. For details, request Catalog 77.
200a *Raymond Div.

Mills, Roller......Company offers Raymond Roller Mill with double Whizzer Separator. Suited for large capacities. Company makes product bulletin available upon request.
200b *Raymond Div.

Mixers......Describes Super Agitators & Mixers. Patented standpipe around propeller shaft assures positive agitation. Patented wearing plate prevents sand-up on shut-down. Bulletin A2-B4.
318a *Denver Equipment Co.

Mixers.....Standardization, high production and complete control of all manufacturing by Philadelphia Gear Works assures you outstanding mixer performance at minimum cost. Bulletin A-256.
33 *Philadelphia Gear Works.

Mixers......Company offers information on their slow-speed Molasses Mixer, a high capacity mixer designed to handle bulky ingredients. Gives assembly diagrams, list prices & dimensions.
408A Strong Scott Mfg. Co.

Mixers, Batch......Catalog describes tilting batch mixers. Covers all features, dimensions and specifications. Also lists other available Gruendler Mixers. For details, request Bulletin B-12.
408B Gruendler Crusher.

Mixers, Pony......The rugged, heavy duty design characteristics of the Day pony mixers enables you to mix a stiffer, heavier paste, resulting in many advantages. Bulletin No. 500.
305 *J. H. Day Co.

Polymerizers, Glassed Steel...... Standard Pfaudler polymerizers offer these benefits: reduced cost, assured purity, easy to clean, easy to operate. Details made available in Bulletin 932.
24-5b *Pfaudler Co.

Presses, Filter......Offer numerous features: lowest cost per sq. ft. of filtering area; produces perfect clarity of filtrate; can be used in decolorizing — deodorizing; etc. Guide to Better filtration.
290 *T. Shriver & Co.

Presses, Filter......Sperry Catalog, complete with charts, tables, and diagrams, will help you in the operation, maintenance and selection of filtration equipment. Request your copy of Catalog 7-E.
391 *D. R. Sperry & Co.

* From advertisement, this issue

Process Equipment......"The ABC's of Speed and Cost Reduction—by Cleveland" is a 4 p. bulletin showing a cross-section of equipment which can help solve problems of speed reduction. Bulletin 521.
409A Cleveland Worm & Gear Co.

Process Equipment...... "A New Approach" to recording, indicating and controlling instruments required in industrial processing is described in a 4 p. bulletin. Request Bulletin No. F-403.
409B Robertshaw-Fulton Controls.

Pulverizers, Screen......Company offers Raymond Ray-Ducer with Screen Separator. Suited for small capacities. Easily accessible to clean or change screens. Request product bulletin.
200c *Raymond Div.

Recausticizing Systems...... "The Dorr Continuous Recausticizing System" describes the operation, equipment units & advantages of D-O's continuous system for alkaline pulping process. Bul. 3301-R.
409C Dorr-Oliver.

Samplers, Automatic......Heavy duty units, extra rigid track and ball-bearing wheels assure positive travel and timing of sample cutter. Available in stainless steel. Bulletin S1-B4.
318c *Denver Equipment Co.

Screens......New 12 p. bulletin describes Walker Back Cleaned Bar Screen. It gives complete design notes, dimension limits, design and wiring diagrams, specifications, etc. Bulletin 20S86.
409D Walker Process Equipment.

Screens, Gyrocentric......Unique gyrocentric action removes any lumps from the granulated product, and assures high screening rates for the various grades. Details in Catalog 507.
325 *Patterson Foundry & Mach.

Separators, Drum......Describes a new drum separator for heavy media plants. Called the "WPD", it is a powerful wet drum permanent magnet unit, designed for efficient recovery. Bulletin 87.
409E Stearns Magnetic.

Tables, Concentration......Separate materials into bands & handle coarsest sands with excellent results. Ideal for separation of groups of particles having similar range of specific gravities. Bulletin TI-B3.
318h *Denver Equipment Co.

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Vaporizers......Bulletin describes a standard chlorine vaporizer system for converting liquid chlorine to dry vapor. Includes description of features, design and construction details. Bulletin 132 B.
410A Whitlock Mfg. Co.

Wire Cloth......80 p. catalog describes company's facilities for fabricating wire cloth parts. Wire cloth parts for screening, filtering and special uses. Provides metallurgical information.
308 *Cambridge Wire Cloth Co.

Wire Cloth & Screen......In order to improve your filtering, straining, sizing operations, specify Ludlow-Saylor wire cloth & screen. Details in Condensed Screen Reference Catalog.
394 *Ludlow-Saylor Wire Cloth.

Pumps, Blowers, Compressors

Compression Systems, Central...... Cardox 3,000-12,000 psi central compression system speeds development of pneumatic components, high-pressure processes. Further details available upon request.
410B Cardox Corp.

Compressors.......Every Norwalk compressor is test-run for 8 hours, then taken down for inspection before shipment. Complete catalog describes compressors from single stage to six stages.
386 *Norwalk Co.

Compressors, Oil-Free......Joy WG-9 oil-free compressors are equipped with carbon graphite piston rings. Need no lubrication, and compensate automatically for wear. For further information, request Bulletin 104-11.
7 *Joy Mfg. Co.

Exhausters, Roof......Four pages of illustrations, performance ratings and diagrams make up Chicago Blower's new Hi-velocity industrial Roof Exhauster bulletin. Request Bulletin CH-101.
410C Chicago Blower Corp.

Fans, Industrial......Stainless Steel General Industrial Fan resists injurious fumes while operating at top efficiency at temperatures up to 800°F. Details made available in Bulletin 521.
251 *New York Blower Co.

* From advertisement this issue

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LITERATURE . . .

Pumps......Available in aluminum bronze, stainless steel, Hastelloy and titanium, Aldrich fluid ends handle all types of liquids—nitric acid, caustic solutions, fatty acids, etc. Data Sheet 100.
184 *Aldrich Pump Co.

Pumps......Triplex pumps for a wide variety of operations where medium pressures are involved . . . for liquids and materials of viscosities as high as 40,000 centipoises. See Bulletin V-241.
2 *Girdler Co.

Pumps......Are built for abusive applications only—abrasion, corrosion, heat, heavily loaded liquids, trash. Complete range of sizes—horizontal and vertical shafts. Details in Catalog 5206.
T429 *Nagle Pumps.

Pumps......Handle most anything that can pass thru a pipe, from free-flowing liquids to non-pourable pastes—materials containing relatively large particles or abrasives. Bulletin 30-CE.
83 *Robbins & Myers.

Pumps......Taber pumps are built for handling chemical solutions, efficiently & economically. Details on horizontal pumps in Bulletin C-355, & vertical pumps in Bulletin V-837.
L419 *Taber Pump Co.

Pumps......If you have a problem where metering, blending or other accurate pumping of liquids is concerned, let Viking help solve it. Use Viking pumps for accurate pumping. Request Bulletin 57Sc.
L420 *Viking Pump Co.

Pumps, Centrifugal......Pumps offer a choice between Hydroseal's added protective flow of sealing water, and Centriseal's ability to deliver abrasive or corrosive pulps undiluted. Brochure 956.
411A Allen-Sherman-Hoff Co.

Pumps, Chemical......Furnishes a complete line of Buffalo pumps, ready to handle corrosive or abrasive liquids at least maintenance cost. For product information, request Bulletin 982.
178 *Buffalo Pumps.

Pumps, Chemical......Lapp Pulsafeeder is a combination piston-diaphragm pump for controlled-volume pumping of fluids. Typical applications, description and specifications in Bulletin No. 440.
157 *Lapp Insulator Co.

Pumps, Chemical......Model 50 chemical pump design features high pressures up to 10,000 psi, and stroke adjustment variable while pump is in full load operation. Details in Bulletin F-741-HP.
411B Seter Engineering Corp.

Pumps, Industrial......Jabsco Industrial Pumps: instantly self-priming; simple, compact, only one moving part; durable neoprene impeller; self-lubricated; trouble-free operation. Catalog sheets.
T413 *Jabsco Pump Co.

* From advertisement, this issue

LITERATURE . . .

Pumps, Metering & Proportioning ......Catalog covers Model "U" and "K" metering and proportioning pumps, the Hills-McCannameter and Model 4411 chemical pump. Catalog 602.
412A Hills-McCanna Co.

Pumps, Process......Type Z4 APCO process pump is ideal for the handling of liquefied petroleum gases, refrigerants & other light non-viscous liquids. Latest design features. Bul. 111-ZA.
T415 *Aurora Pump Div.

Pumps, Proportioning......Displaces entire contents of the cylinder at each stroke of piston irrespective of stroke adjustment. External check valves easily removed. See Catalog 406.
149 *American Instrument Co.

Pumps, Reciprocating......Brochure features Aldrich triplex, quintuplex, septuplex, and nonuplex reciprocating pumps. Presents design and material specifications, etc. See Data Sheet 100.
412B Aldrich Pump Co.

Pumps, Slurry......"The Oliver Diaphragm Slurry Pump" describes the features, applications, sizes and capacities, installation instructions and power requirements of unique slurry pump.
412C Dorr-Oliver Inc.

Pumps, Vacuum......Bulletin shows how 35 product problems were solved with Gast rotary air motors, air compressors, vacuum pumps. Gives application ideas for product designers. Bulletin 1054.
412D Gast Mfg. Corp.

Pumps, Vacuum......Bulletin describes company's three, four and five stage steam jet vacuum pumps and vacuum boosters. Describes both condensing and non-condensing types. See Bulletin 5H3.
412E Schutte & Koerting Co.

Pumps, Vacuum......Catalog includes specifications for complete line of Stokes pumps, valuable tables of formulations, constants, and conversion factors used in vacuum processing. Catalog 752.
412F F. J. Stokes Corp.

Snubbers......Stops noise from intake & exhaust of air, etc. & stops pulsation caused by line surges from compressors, pumps, & blowers. Company offers literature on pulsation snubbers.
T414 *Burgess-Manning Co.

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Vents......Complete Venting Manual shows operating features and special applications of complete Protectoseal line. "In-line" vent avoids frequent, costly and highly dangerous roof-top inspection.
393a *Protectoseal Co.

Services, Processes, Misc.

Cleaning, Chemical......Report discusses nature of soils usually encountered in chemical processing equipment, and the Oakite compounds developed to remove them. Request Service Report B-6039.
413A Oakite Products.

Commutator Maintenance......27 p. booklet covers: maintenance requirements; factors affecting commutation; and carbon brush materials. Solve commutation problems with Booklet B-6150-A.
413B Westinghouse Elec. Corp.

Fire Protection......28 p. covers various methods of fire detection, fire prevention, fire control and fire extinguishment associated with the field of "Special Hazard" fire protection. Catalog 73.
413C "Automatic" Sprinkler Corp.

Flotation......More large plants are installing "Sub-A's" for entire flotation job, because they give maximum recovery at a low cost per ton. Simplified continuous operating. Bulletin F10-B81.
318g *Denver Equipment Co.

Glasses, Flat......Properties, applications and characteristics of Corning flat glasses are presented in a new 4 p. illustrated bulletin. Presents data on several types of glass. Bulletin PE-34.
413D Corning Glass Works.

Gloves, Industrial......Catalog describes and illustrates Wilson's complete line of curved-finger Rubber, Latex, Neoprene, Buna-N, and Compar Plastic Gloves. Request your copy.
413E Wilson Rubber Co.

Heads, Safety......Safety heads act as controlled weak spots in vessels, and would fail safely, with minimum danger from fire, at a lower pressure than the vessels themselves. Catalog.
300 *Black, Sivalls & Bryson.

Laboratory Equipment.....Batch and continuous test models of crushers, screens, ball mills, pulverizers, rod mills, classifiers, agitators, pulp distributors, feeders, etc. Bulletin LG3-B10.
318i *Denver Equipment Co.

Lubricators, Automatic......Bulletin describes detailed planning of all systems and their many applications to a wide range of machinery. Tells how to obtain best results from any system. Bulletin 4A.
414A Bijur Lubricating Corp.

* From advertisement, this issue

LITERATURE . . .

Model Supplies......Catalog presents those items which are most common to the field of engineering modelmaking. Company offers listed items and the service of developing others.
414B Engineering Model Assoc.

Odor Control, Petroleum......"Alamask Odor Control for the Petroleum Industry" presents data based on practical tests within the refining fields. Recommends specific odor control chemicals to use.
414C Rhodia, Inc.

Plants & Processes, Fats & Oils......"Plants and Processes for the Fats and Oils Industry" describes equipment which offers top economy in the extraction and preparation of these products.
414D Blaw-Knox Co.

Polyethylene Ware...... Brochure lists complete line of polyethylene ware for laboratory use. Illustrates and describes items made of standard polyethylene as well as high heat polyethylene.
414E Scientific Glass Apparatus.

Safety Equipment, Storage Tank..... Company offers Safety Bulletin Series on "Flammable Liquids, their characteristics, hazards and safe handling." Includes: conservation type vents, tank openings, etc.
393b *Protectoseal Co.

Springs, Breather ...... Breather Springs solve the problem of damaged insulation when hot tanks, towers, pipes and vessels expand and contract. Additional information is available upon request.
414F Techalloy Co.

Waste Treatment, Industrial...... Bulletin covers bar and disc type screens, traveling water screens, screenings grinders, grit collectors and washers, cross collectors, scum removers, etc. Catalog 905.
414G Jeffrey Mfg. Co.

Water Well Systems......Covers Layne water well systems, oil and water lubricated Vertical Turbine Pumps, special water well drilling, service work, shutter screens, irrigation wells and pumps, etc. See Bulletin No. 100.
414H Layne & Bowler.

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THIS MONTH'S

Products Index

• **Your complete index to chemicals, materials, equipment and services taken from this issue's advertisements, new products departments and "Guide to Technical Literature."**

• **Products listed feature code numbers which show the page on which they appear. L (left), R (right), T (top), B (bottom) indicate ad location; A, B, C, etc. and a, b, c, etc. identify specific product items on an editorial page or in an ad.**

• **You can get information on any listings by circling its key number on the Reader Service Postcard (see inside back cover). Replies will come direct from the companies manufacturing the products.**

Chemicals

PRODUCTS . . .

Equipment

PRODUCTS . . .

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